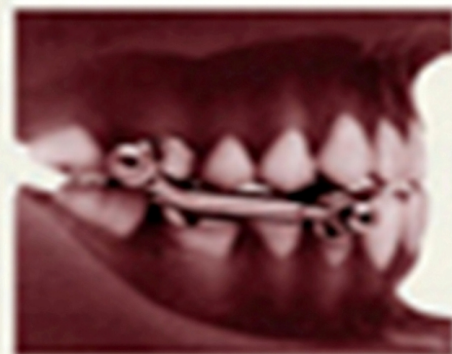




Synopsis of Orthodontic Treatment



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Purva Kumar

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Synopsis of Orthodontic Treatment

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*This book is dedicated to the
dental fraternity
and to
my dearest daughter
SANJANA*

Preface

A lot of books have been written on the basic components of orthodontic curriculum, which include normal growth and development, etiology and classification of malocclusion, biology and mechanism of tooth movement, diagnosis and treatment planning, orthodontic materials, orthodontic appliances and so on. This book, as the title suggests, is a comprehensive source of information concentrating on the clinical aspects of orthodontic treatment. The book is written with an objective to guide the dental students, especially the students mastering in the branch of orthodontics, to focus on the practical aspects of management of malocclusion.

The layout of the topics would explain the steps and approach to be executed for a particular case to achieve the desired final result. This includes learning about the patient's appraisal, typifying the case, organizing the therapy, specifying the dental and skeletal movements required, selection of appliance and planning the post-treatment retention.

The book is concise in nature; hence, a list of references is also included for learning the minute details of the subject.

I sincerely hope that the book would be a help to the undergraduate and postgraduate students, and the general dental practitioners as a reference guide. I also wish to thank the publishers who have encouraged me in this effort.

Purva Kumar

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Introduction to Orthodontic Treatment

In order to understand the contents of this subject, it is essential that the terms used frequently in the text are understood well. These basic terms are:

1. Malocclusion
2. Orthodontics
3. Treatment of malocclusion

The above three terms are interrelated. The explanation of the term 'malocclusion' leads to the need to understand the term 'orthodontics' in the right perspective. This, in turn, leads to recognize and understand the term 'treatment'. So, let us define malocclusion first.

MALOCCLUSION

Malocclusion is a condition where there is a departure from normal occlusion. So, it becomes essential to discuss some more about *normal* occlusion, which is collectively contributed by six basic keys. This is in line with what has been discussed by L Andrews. These basic keys are:

1. *Molar relationship*: The mesio-buccal cusp of upper 6 occludes with the mesial surface of the mesial-buccal groove of lower 6.
2. *Crown angulation*: The gingival portion of the long axis of each crown is distal to the incisal portion.
3. *Crown inclination*
4. *No rotations*
5. *No spaces; tight contact points*
6. *Flat or a slight curve of SPEE*

Now, let us define 'orthodontics'

ORTHODONTICS

Orthodontics is a dental science that deals with the prevention and correction of arrested, perverted and abnormal development of teeth and jaws.

Now, there is a big question as to why orthodontic treatment is needed. This is done:

1. To improve dental and facial aesthetics.
2. To restore proper function of teeth.
3. To eliminate harmful oral habits.

4. To reduce caries susceptibility by increasing the cleansing capability of the teeth.
5. To eliminate periodontal pathology caused due to malocclusion of teeth.
6. To correct or prevent certain temporomandibular joint abnormalities.
7. To aid in correction of speech defects.
8. To correct malpositioning of teeth prior to construction of bridge work.
9. To complement surgical correction of skeletal deformities.
10. Orthodontic treatment may be necessary for postaccidental treatment of teeth loss or occlusal interference.
11. To improve the looks and hence, the confidence of the patient.

Now, to commence orthodontic treatment, it is very important to diagnose the malocclusion. *Diagnosing* malocclusion is the art of recognizing and classifying abnormality from its features and symptoms.

Diagnosis in orthodontics should be comprehensive and not focused on a single aspect. It requires the collection of *database* of information and distillation from the database into a clearly stated *problem list*.

TREATMENT OF MALOCCLUSION

Treatment planning, on the other hand, is to synthesize the possible solutions to these specific problems into a specific treatment that is best for the particular patient. Treatment planning is the second step in the treatment of malocclusion, the first step being diagnosis of the problem.

The following sequence of steps is to be taken with a patient who has malocclusion:

1. Recognize the problem and the malocclusion in an initial clinical examination—Screening.
2. Collection of database (Records):
 - i. History given by the patient
 - ii. Patient's expectations from the orthodontic treatment
 - iii. Study models
 - iv. Facial photographs
 - v. Radiographs
 - a. Cephalograms
 - b. OPG (Ortho Pantomo Grams)
 - c. IOPA (Intra Oral Peri Apical X-rays)
 - d. Specialized radiographs
3. Distillation of the records and formation of a problem list.

Initial problem list

- | | |
|-------------------------|---------------------------|
| a. Orthodontic problems | b. Endodontic problems |
| c. Periodontic problems | d. Prosthodontic problems |
| e. Surgical problems | |
-

Decide a step-by-step approach by prioritization of the problem as per individual case.

4. Formation of orthodontic problem list as per different categories of problems.
 - a. *Alignment*: Spacing and crowding
 - b. *Profile*: Convex, straight, or concave
 - c. *Transverse deviation*: Cross bite
 - d. *Sagittal deviation*: Angle's class of MO
 - e. *Vertical deviation*: Deep bite, open bite
 - f. Combination of above problems in two or three planes of space

Prioritization of the problem should be done according to *chief orthodontic complaint* of the patient and the nature of the problem.
5. *Develop a tentative treatment plan*:
 - a. Treatment possibilities
 - b. Cost effectiveness
 - c. Strategy that is best for a particular patient
6. Develop a final treatment plan similar to one given below :

Treatment Plan

- i. Goals: In response to problem list
- ii. *Anchorage source*:
 - a. Teeth
 - b. Jaws
 - c. Cranium
 - d. Combination of the above
- iii. *Complicating factors*:
 - a. Growth potential of the patient
 - b. Typical tooth movements required
 - c. Poor oral hygiene
 - d. Patient's expectations
 - e. Cost of treatment

Appliance Plan (on the basis of I, II, III in treatment plan)

- A. Removable appliance
- B. Fixed appliance (choose technique)
 - a. Light wire technique
 - b. Edgewise appliance
 - c. Preadjusted edgewise appliance
- C. Semi-fixed appliance

Retention plan (on the basis of I, II, III in the treatment plan and A, B, C in the appliance plan):

- a. Removable retention
- b. Semipermanent retention
- c. Permanent retention

7. Consult with the patient and his/her parents about the diagnosis and the treatment plan. Treatment should begin after proper agreement is made by all parties at the consultation appointment.

2

Factors Considered in Treatment Planning

The following factors are considered in the treatment planning:

I. CASE SELECTION

- A. Predicting patient's cooperativeness and appraisal of the family.
- B. Classifying the malocclusion and typifying the case.

II. PLANNING AND ORGANIZING MECHANO-THERAPY

1. Define treatment goals.
2. Specification of the required tooth movements and bony changes.
3. Appliance selection plan
4. Retention plan.

FACTORS LIMITING ORTHODONTIC TREATMENTS

Factors that bring limitations to orthodontics could be related to the *patient* or to the *treating dentist*, or could be related to the *nature of the orthodontic problem* itself. These factors are as follows:

1. *Limiting growth and age factors*: As the age of the patient increases beyond the *late adolescent period*, the growth of the patient gradually stops. So, even the small amount of vertical growth on which orthodontics relies, is lacking. This makes the tooth and jaw movement more difficult and precludes orthognathic surgery.
2. *Limiting skeletal factors*: When there are major skeletal dysplasias, it is beyond the scope of orthodontic treatment to correct the dysplasia, e.g. maxillary or mandibular prognathism.
3. *Limiting neuromuscular factors*: When there are abnormal neuromuscular forces like abnormal oral habits (e.g. infantile tongue thrust), then, the orthodontic therapy encounters many difficulties in correction of the underlying malocclusion.
4. *Limiting dental factors*: When there is major discrepancy between the arch size and tooth material, or heightened susceptibility to caries and periodontal disease, it becomes difficult to manage by orthodontic means alone.
5. *Limiting expectational factors*: When the patient has unrealistic expectations from the orthodontic treatment, it becomes difficult to satisfy the patient by this treatment.

6. *Limiting motivational and co-operational factors:* When the patient is not well motivated and not well co-operative during the orthodontic treatment, then, even a well-planned treatment would end up in poor final results.
7. *Limiting skill factors:* Inadequate experience and skill of the treating clinician would lead to difficulties in orthodontics.

Keeping in view the limitations to orthodontic treatment, let us learn about the important factors considered in treatment planning:

I. CASE SELECTION

A good patient makes a good orthodontist and a good orthodontist selects his cases wisely. As discussed earlier, the following factors influence case selection:

Predicting Patient's Cooperativeness and Appraisal of the Family

Every dentist has, on an occasion, wondered why some patients are difficult to treat even when the procedure makes only a small demand on their cooperativeness while other patients are cooperative even under taxing procedures. In this context, *Grabner* has correctly said: "Some orthodontic techniques rely on patient's cooperativeness more than others, but all of them fail without it". Thus, it is essential to predict the motivational level of the patient, which, in turn, would predict the level of cooperation extended by the patient during the treatment.

Many well-planned and well-executed orthodontic treatment plans have failed because the parents and patients did not know the nature of the procedure and were tired of the procedure before the goal was reached. Hence, do the following to check the perceptual and motivational level of the patient:

1. Put some questions to the patient like:
 - a. Who inspired or suggested the orthodontic treatment—you, parents, friend or another patient?
 - b. Why do the patient and the family think that the orthodontic treatment is required? What is the exact expectation of the result from the treatment?
 - c. Do they have an idea about the duration, cost, and difficulties of the treatment?
2. Then explain the purpose, aim, benefits, and the routine of orthodontic treatment. Try and analyze how much the patient has followed by talking to him and questioning politely.
3. See the enthusiasm of the patient and his parents in each visit.
4. Observe the general personality factors of the patient like:
 - a. *Grooming:* See general cleanliness.
 - b. *Intelligence quotient:* Check grasping alertness and memory of the patient.

- c. *Annoying habits*: Observe if habits such as scratching, fidgeting are present.
- d. *Anxiety level*: Note whether the patient is cheerful and lively or anxious kind of person.
- e. *Self sufficiency*: Observe whether he is self sufficient or dependent on his parents.

CLASSIFYING THE MALOCCLUSION AND TYPIFYING THE CASE

Firstly, it is essential to classify and typify the case in terms of treatment procedure and Angle's classification of malocclusion. The method suggested here is to study and analyze three factors. This would segregate the malocclusion into correct and specific categories. These three factors are:

1. Timing of orthodontic treatment
2. Type of facial skeletal pattern
3. Space availability and space requirement

Timing of Orthodontic Treatment

Treatment can be divided into three phases according to its onset.

Early Treatment

Treatment of the skeletal problem is undertaken when active growth is present in the early years. Early treatment comprises of *preventive orthodontics* mainly in primary dentition and *interceptive orthodontic treatment* in mixed dentition. This has been discussed in detail, in separate chapter in the book.

Late Treatment

Treatment is begun so late that the advantage of growth can not be taken; hence the underlying skeletal problem has to be camouflaged by dental compensation carried out in complete permanent dentition. Late treatment comprises of *corrective orthodontics* in permanent dentition, which has been discussed in detail in a separate chapter of the book. Special cases of late treatment require surgical orthodontic treatment.

Diphasic Treatment

It is a 2-phase treatment. Treatment of the skeletal problem is undertaken during the early years when active growth is present. Later, treatment of dental malocclusion is undertaken after the eruption of permanent teeth.

Type of Facial Skeletal Pattern

Skeletal pattern is typified as per the skeletal base. Skeletal bases are classified into CI-I, II and III. Generally, clinically, Ballard's classification is used to know the skeletal relationship at the chair side. This is: Skeletal

Class I—In this case, the inclination of the teeth is normal and the dental base relationship is also normal. The axis of the lower incisor would pass through the crowns of the upper incisors.

In the case of *Skeletal Class II*, the lower apical base is relatively too far back. The lower incisor axis would pass palatally to the upper incisor crowns. The lower apical base in the case of *Skeletal Class III*, is placed relatively too far forward and the projection of the lower incisor axis would pass labially to upper incisor crowns. Here, the reader is reminded of the *two-finger diagnostic test* for the skeletal assessment in the *antero-posterior plane*. Two-finger test can be done clinically, either extraorally or intra-orally (Fig. 2.1).



Fig. 2.1. Assessment of skeletal jaw relationship. Normal: The fingers are at same level and hand is at even level. Prognathism: The middle finger is ahead of the index finger and hand points downward. Retrognathism: Index finger is ahead and hand points upward

Fore finger is placed corresponding to point A and middle finger corresponding to point B.

Sk CI-I: Forefinger is very slightly ahead of the middle finger.

Sk CI-II: Forefinger is much ahead of the middle finger.

Sk CI-III: Middle finger is ahead of the forefinger.

Skeletal pattern should also be judged clinically and cephalometrically in the vertical plane. There could be three cases:

1. *Normal facial angle case*: Medium face.
2. *Low facial angle case*: Short face or skeletal deep bite.
3. *High facial angle case*: Long face or skeletal open bite.

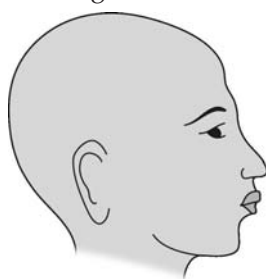


Fig. 2.2: Favorable facial pattern with normal facial angle

The reader is reminded that this book would not be going into the details of diagnosis. According to the skeletal assessment, the treatment plan and choice of mechano-therapy would vary from functional neuromuscular appliance to plain orthodontic appliance, orthopedic appliance or a combination of the above appliances.

Space Availability and Space Requirement

The arch perimeter analysis would help to know whether the available space is *abundant, deficient or sufficient*. Space availability, space creation and utilization is required for the following corrections as a part of the treatment:

1. *Retraction of protruded teeth*: For every millimeter of retraction required, 2 mm of space is required. Extraction of certain teeth might be required for retraction of proclined teeth.
2. *Correction of crowding*: For every millimeter of de-crowding, the same amount of space is required for aligning the teeth.
3. *Alignment of rotated anterior teeth*: For every millimeter of de-rotation required, the same amount of space is required for aligning the teeth.
4. *Alignment of rotated posterior teeth*: Space is created when rotated posterior teeth are aligned as the posterior teeth are broad labio-lingually.
5. *Correction of molar relationship*: The space required for the mesial or distal movement of molar is as per the actual movement planned.
6. *Levelling the curve of spee*: For every 1 mm of leveling, 0.5 mm of space is required. An excessive curve of spee will not only limit the amount of retraction of the maxillary anterior teeth but can also lead to relapse of the condition.

II. PLANNING AND ORGANIZING MECHANO-THERAPY

Treatment Goals

To achieve the objectives of esthetics, function and stability, the orthodontic treatment goals are:

- a. *Ideal treatment*: When there are no or very minor limiting factors (as mentioned earlier in this chapter), then we can achieve six keys of normal occlusion. In most of the skeletal CI-I patients, ideal treatment goals can be defined and achieved.
- b. *Camouflaged or compromised treatment*: Sometimes due to the presence of one or many orthodontic limiting factors, we cannot achieve the ideal treatment goals. Hence, we try to camouflage a less apparent problem by correcting the more apparent problem. Skeletal CI-II problems can usually be camouflaged well and most camouflage treatment is chosen for CI-II patients wherein the objective of treatment is to correct the malocclusion while making the underlying skeletal problem less apparent. Extractions of teeth provide space necessary for teeth movement and hence, it is possible to obtain correct molar and incisor relationships despite the underlying CI-II jaw relationship. Camouflage

implies that repositioning the teeth by displacement relative to their bony base will have favourable effect on facial esthetics and stable occlusion. Skeletal CI-III with long face problems cannot be camouflaged well and the skeletal problem cannot be concealed by correcting the occlusion. But in the case of mild to moderate CI-III with good vertical facial proportions, the extraction of teeth for camouflage would lead to correction of the minor skeletal discrepancy. To summarize,

- i. Growth modification is most successful in *preadolescent patients*.
- ii. Camouflage is most useful for adolescents with moderately severe problems.
- iii. Jaw surgery is most useful for patients with no remaining growth potential and severe skeletal problems.

Specification of the Required Tooth Movements and Skeletal Changes

For example,

- a. Specifying movements to remove interference to growth and normal function like destructive oral bits, premature occlusal contacts that deviate path of closure, cross bites, etc.
- b. Specifying movements for correction of occlusion and jaw relationship in any or all three planes space, i.e. antero-posterior, vertical, and transverse.
- c. Specify individual tooth positioning like labiolingual rotation of upper anteriors, intrusion of lower anteriors, extrusion of molars, etc.

Appliance Selection

Appliance selection mainly depends on the treatment goals defined for individual cases, the dental movements and skeletal changes specified for individual cases and patient's affordability and cooperativeness. Select one of the following appliances as per need of the case.

- a. *Removable appliances*: Removable appliances of two types are used mainly in two major applications. These are:
 - i. Removable functional appliances for growth modification during the mixed dentition. *Passive tooth borne functional appliances* have no intrinsic force generating capacity from springs or screws and depend only on soft tissue stretch and muscular activity to produce treatment modifications, e.g. plain activator, bionator, Herbst appliance (twin block). *Active tooth borne functional appliances* are modification of activator and bionator, which include springs or expansion screws in the original design, e.g. expansion activator, orthopaedic corrector. *Tissue borne functional appliances* are only borne by the soft tissue, e.g. Frankel's functional regulator.
 - ii. Removable appliances for limited tooth movements, these are:
 - Active plates for arch expansion, which move groups of teeth to expand the arch perimeter.

- Removable appliances with springs for positioning the individual teeth. These springs contact the tooth surface at only one point and it is difficult to use them for any movement other than tipping.
- b. *Semi-fixed appliances*: These are combination of removable and fixed appliances. These can be used for multiple purposes like expansion (e.g., palatal expanders), overbite correction, overjet correction, e.g. removable acrylic appliance with elastics on anterior bonded teeth, or fixed functional appliances like Herbst appliance. Jasper jumper, MARS appliance, etc.
- c. *Contemporary fixed appliances*: These have two components; passive components like bands, brackets, buccal tube, lingual cleat, lingual buttons, eyelets, lingual hooks; active components like separators, arch-wires, springs, elastics, etc.

Choose a suitable technique from the following different techniques of fixed appliances:

1. Begg light wire technique
2. Edgewise technique
3. Labiolingual technique
4. Straight wire or preadjusted edgewise technique
5. Tippedge technique
6. Lingual orthodontic technique
7. Bio-progressive technique
8. Combination of begg and edgewise technique.

Knowing the basic differences between Begg's light wire technique and edgewise technique would help in the selection of the technique as per demand of the case. These differences are:

- Begg's technique uses brackets with a vertical slot, which is roundish in cross-section and has a single point contact with the wire and hence, double tipping tooth movements (crown tipping, root tipping) take place. Edgewise technique uses brackets with a horizontal slot, which is rectangular in cross-section. Hence, there is two-point contact with the arch wire. As a result, bodily tooth movement takes place.
- Begg's technique uses light and continuous forces; the treatment results are relatively faster and root resorption is relatively less. Edgewise technique uses heavy and intermittent forces at times; the treatment result is slower and root resorption rate is higher.
- Final alignment of teeth is average in Begg's technique whereas the final tooth positioning is good in edgewise technique.

ADVANTAGES OF FIXED APPLIANCE OVER REMOVABLE APPLIANCE

There are a few advantages of fixed appliance over removable appliances:

- Complex tooth movements like intrusion, uprighting, torquing, derotations, bodily movements, etc. can be carried out by fixed appliance technique (FAT).

- Multiple tooth movements can be carried out at the same time like cross bite correction, de-crowding, bite opening, etc.
 - Good results with all types of extraction cases are achieved.
 - Better anchorage control is possible in the cases where post segments have to be moved mesially.
 - Better tooth positioning can be achieved as compared to removable technique.
4. *Retention plan:* At the time of commencement of treatment, the final result has to be visualized and retention phase has to be planned (see another chapter on the subject).

3

Divisions of Orthodontic Treatment

A very common question asked in the field of orthodontic treatment is: "What is the correct age to start orthodontic treatment". The answer is: "The treatment should be started as early as the problem is first noticed". This could be either in primary dentition, or in mixed dentition, permanent dentition or in the postpermanent dentition. The problems in the different dentition periods are different from each other in nature and hence, different kind of orthodontic management is demanded for each dentition period. Therefore, the orthodontic treatment can be broadly divided into four phases:

1. *Preventive orthodontic treatment*: Usually commenced in the primary dentition period, as early as 4 to 5 years of age.
2. *Interceptive orthodontic treatment*: Usually commenced in the mixed dentition period (6 to 12 years), as early as 6 to 7 years of age.
3. *Corrective orthodontic treatment*: Commenced in permanent dentition period, as early as 12 to 13 years of age.
4. *Surgical orthodontic treatment*: Commenced when all the permanent teeth have fully erupted and in pure adult cases. The patient could be of any age above 15 years.

PREVENTIVE ORTHODONTICS

GRABER has defined it as "*the action taken to preserve the integrity of what appears to be normal occlusion at a specific time*". Treatment plan for preventive orthodontics carried out mainly in primary dentition period is:

- a. to eliminate factors inhibiting normal growth of face and jaws;
- b. to restore or maintain normal function.

This includes the following preventive approach:

1. Parent counseling
2. Early caries control and correction
3. Early recognition and correction of abnormal oral musculature and related deleterious oral habits
4. Maintaining lost space with space maintainers in the case of early loss of deciduous teeth.
5. Correction of abnormal frenal attachments.

Conditions generally treated in the primary dentition period with the use of preventive orthodontics are:

1. Anterior cross bite.

2. Posterior cross bite.
3. Space loss because of early loss of deciduous teeth.
4. Retained deciduous teeth (mainly incisors), which interfere with the eruption of permanent teeth.
5. Abnormal occlusal contacts that disturb the equilibrium of the otherwise normal occlusion.
6. Habits that cause abnormal function and effect esthetics.
7. Open bite due to abnormal oral habits.

INTERCEPTIVE ORTHODONTICS

This is defined as *“that phase of science and art of orthodontics employed to recognize and eliminate potential irregularities and malpositions in the developing dentofacial complex”*. Treatment plan for interceptive orthodontics done mainly in the mixed dentition is:

1. To eliminate a developing malocclusion or to make it less severe so as to allow corrective orthodontics to deliver a conservative and stable result in the shortest possible treatment time.
2. To ensure that there is no loss of arch length due to premature loss of deciduous teeth, or due to rotated teeth.
3. To ensure that an oral habit does not become fixed and affect the normal growth and development.
4. To guide the jaw growth by using myofunctional appliances.

Conditions generally treated in the mixed dentition period with the use of interceptive orthodontics are:

1. CI-II skeletal malocclusion with maxillary prognathism, mandibular retrognathism or a combination of both by using myofunctional therapy.
2. CI-III skeletal malocclusion due to maxillary retrognathism, mandibular prognathism or both by using myofunctional therapy or orthopaedic appliances.
3. Developing dental crowding by performing serial extraction.
4. Destructive oral habits by muscle exercises, motivation and habit breaking appliance.
5. Loss of space, which is lost when the permanent first molar tips into the extraction space of deciduous second molar. This happens when the deciduous second molar is prematurely removed. This mesial drifting of permanent molars leads to loss of arch length, which may impede on the space required for the second premolar to erupt. Loss of space is treated by space regaining methods.
6. *Anterior and posterior cross bites*: If the cross bites are not treated in time, it could lead to skeletal malocclusion, which would require corrective orthodontic treatment later on. So, cross bites should be corrected as soon as they are detected. They are easier to correct in the mixed dentition stage.

7. *Loss of primary teeth*: The space is maintained by giving space maintainers.
8. *Oligodontia*: Maintaining the space till permanent prosthesis is provided or orthodontic closure is done.
9. Extraction of supernumerary teeth.
10. Spacing between permanent incisors if space closure is required.

CORRECTIVE ORTHODONTICS

It is that phase of orthodontics that recognizes the existing malocclusion and employs certain technical procedures to reduce or eliminate the problem and the attendant sequel. Corrective orthodontics corrects all malocclusions possible to correct in the permanent dentition. Corrective orthodontics implies an effort to make the patient's occlusion as ideal as possible, repositioning almost all the teeth in the process. The best time for corrective or comprehensive orthodontic treatment is during adolescence when all the permanent teeth have just erupted and some vertical and anteroposterior jaw growth is remaining. Corrective treatment is also possible for adults but, it poses certain problems, which have been discussed in chapter on Corrective Orthodontics.

Corrective treatment, usually, requires a complete fixed appliance. Any of the fixed orthodontic technique can be chosen as per requirement of the case and skill of the clinician. Major goals to be achieved through corrective treatment are:

- Alignment
- Leveling
- Space closure
- Correction of molar relationship
- Closure of extraction space
- Adjustment of individual tooth position
- Orthodontic camouflage of skeletal malocclusion
- Torque of incisors
- Root paralleling at extraction sites
- Correction of midline discrepancies
- Final settling of teeth
- Removal of fixed orthodontic attachments and retention of the achieved results.

SURGICAL ORTHODONTICS

It is that phase of orthodontics that employs surgical procedures in conjunction with orthodontic treatment to facilitate correction of malocclusion by orthodontic techniques, to correct severe dentofacial problems, to stabilize and retain postorthodontic results. Thus the major goals of surgical orthodontics are:

1. To aid or facilitate correction of malocclusion by orthodontic technique.
2. To correct severe dentofacial problems where neither growth modification nor camouflage offers a good post-treatment result.

3. To help stabilize postorthodontic results.
4. To prevent relapse.

The procedures undertaken under this heading could be performed either in the soft tissue or in the hard tissue. These are:

1. *Surgical uncovering of impactions*, which are done when
 - The tooth is favorably positioned with its apex close to the correct position.
 - The path of eruption is not obstructed.
 - Adequate space is available in the arch. It is either achieved orthodontically or by extraction.
2. *Surgical removal of impacted teeth* is done when the tooth is so badly displaced that it cannot be made to erupt normally or with orthodontic means and can be removed without undue danger to the other teeth (canine, third molar).
3. *Surgical transplantation* is, usually, carried out in younger adults where the bone is elastic and the tooth can be removed with minimum damage to the periodontium, e.g. transplantation for misplaced canines.
4. *Labial frenectomy* is done when a midline diastema is being caused or held by a thick short fibrous labial frenum attached to the incisive papillae.
5. *Pericision for retention after orthodontic tooth movement*: Supracrystal gingival fibers of an orthodontically moved tooth are sectioned and allowed to reattach at a new position on the root surface.
6. *Extraction of teeth for creation of space*: Therapeutic extractions of healthy erupted teeth is done as a part of overall orthodontic treatment to gain space. Submerged teeth and retained deciduous teeth are also extracted.
7. *Orthognathic surgery*: For patients whose orthodontic problems are so severe that neither growth modification nor camouflage offers a good result, surgical realignment of jaws or repositioning of dento-alveolar segment is a good possible treatment. For these patients, surgery is not a replacement for orthodontics but is properly co-ordinated with orthodontics to achieve good overall results.

SURGICAL PROCEDURE

1. *For correction of anteroposterior relationships*:
 - Le Forte I down fracture to reposition Maxilla.
 - BSSO (bilateral sagittal split osteotomy) for mandibular advancement and mandibular setback.
 - TOVRO (transoral vertical oblique ramus osteotomy) for mandibular set back.
2. *For correction of vertical relationships*:
 - a. Le Forte I down fracture of maxilla with superior repositioning of the maxilla after removal of bone from lateral walls of nose, sinus and nasal septum for correction of skeletal open bite (long face).
 - b. Inferior border osteotomy of the mandible to reduce vertical height

- of the chin and augment it horizontally for long face patients with elongated and retruded anterior segment.
- c. Sagittal split mandibular ramus surgery to rotate the mandible down and the genial angle up for patients with skeletal deep bite and associated mandibular deficiency.
3. *For correction of transverse relationships:*
 - a. Surgically assisted palatal expansion using bone cuts to reduce the resistance followed by rapid expansion with jack screw.
 - b. Parasagittal osteotomy is done in the lateral floor of the nose or medial floor of the sinus for maxillary expansion in the cases of skeletal lingual cross bite. In expansion, the bone resulted in the fracture or some back bone is used to fill the void created by the transverse movements of the buccal segments.
 - c. Leforte I osteotomy is carried out to reposition the maxilla with sagittal split osteotomy of mandibular ramus to correct the facial asymmetries.
 4. For cosmetic surgery in orthognathic treatment:
 - *Genioplasty:* The symphysis portion of the chin is sectioned (by a lower. Border Osteotomy approach) anterior to the mental foramen and then, repositioned in all the three places of space. The lingual surface remains attached to the genioglossus and geniohyoid muscles in the floor of mouth, which provided the blood supply.
 - Another augmentation technique is to use some kind of implant material.

Successful management requires a combination of orthodontic and surgical treatment. Usually, dental corrections are done before surgery and the teeth are positioned in relationship to the individual skeletal components. Following surgery when healing has taken place, orthodontic treatment can be initiated to refine the occlusion. The contemporary Edgewise appliance provides excellent stabilization for postaccidental traumatic cases along with surgical correction.

4

Preventive Orthodontic Treatment

Practiced mainly in the deciduous dentition period, preventive orthodontics has been defined by Graber as the action taken to preserve the integrity of what appears to be normal occlusion at a specific time. Preventive orthodontics is based on the importance of deciduous dentition in providing a base for the correct growth of jaw and correct positioning of the permanent teeth.

The following measures should be taken by the clinician when he first encounters a developing problem in the deciduous dentition.

1. *Parent counseling and education:* The parents must be made to realize that deciduous dentition is as or even more important than the permanent dentition. Audio-visual aids could also be used for this purpose.
 - a. *Prenatal diagnosis and education:* If the dentist gets an opportunity to counsel the parent at the prenatal stage, it would greatly benefit the child and the parent at a later stage. This includes explaining to the mother the value of food containing calcium and phosphorus, in addition to a balanced diet. She should be advised to take plenty of milk, milk products, fruits to allow adequate formation of deciduous teeth and arches. The importance of oral hygiene should also be explained to the mother as a mother with poor oral hygiene could pass on the bacterial strains to the baby.
 - b. *Postnatal diagnosis and education:* This can be done at various stages or at different ages.
 - i. *At the age of 6 months to 1 year:* Eruption of deciduous teeth or teething starts at this time. Parents should be made aware of the teething difficulties like irritation of the gum-pads, elevated body temperature and loose motions. Also, the importance of breastfeeding in the prevention of TMJ development disorders and in the prevention of developing tongue thrust should be explained. The deleterious effects of bottle-feeding should be explained and the child should be motivated to drink from a glass by the age of one year. The parents can be educated to clean the deciduous dentition with clean wet cloth or a finger brush as a preventive measure for rampant caries.
 - ii. *Between the age of 2-3 years:* This is the time to educate the parents to drop the bottle-feeding habit and to initiate proper brushing of teeth twice a day. Also, dentition should be examined for

presence of any initial decay or eruption problem. This is the time for clinically examining the full deciduous dentition. The examination should include the study of molar canine relationship and presence of cross bites, supernumerary teeth, or missing teeth, etc. Also, check for presence of oral habits and explain the effects on the developing occlusion.

- iii. *At the age of 5-6 years:* This is the time for educating the parents about the beginning of the shedding process of the deciduous dentition, which would continue till the age of 12 years. Check for the early loss of deciduous teeth and the need for space maintenance.
2. *Early correction and control of caries:* Caries, especially proximal caries if not timely attended, could lead to a malocclusion in the succedaneous dentition. Thus, the primary measures of controlling caries like nutritional and diet counseling, fluoride content in water, pit and fissure sealants, topical fluoride application and measures like filling of decayed tooth or pulp treatments should be taken to preserve the tooth till the normal time of exfoliation.
3. *Prevention of space loss and maintenance of the arch integrity:* Early loss of any deciduous tooth should be prevented as this would affect esthetics, development of jaw structures, speech, and mastication. Space maintainers should be used in the cases of unavoidable extractions of deciduous teeth.
4. *Elimination of abnormal oral habits:* Infantile tongue thrust may, sometimes, persist beyond 2 years of age. In that case, preventive means should be taken to break this habit as it would lead to effects like proclination of anterior teeth, spacing between anterior teeth, open bite and narrowing of the maxillary arch at a later stage. Observation and motivation should be done till 5-6 years of age. Habit breaking appliances can be given in the mixed dentition period, if the habit persists during this period.

Thumb sucking or digit sucking is considered normal till the age of 4-5 years. But, if it persists beyond this time, then motivational therapy like explanation and reward therapy can be undertaken. If mouth breathing is detected, proper medical treatment should be given. Pre-orthodontic trainers or oral screens could be used to train the child to breathe through his nose.

5. *Other means:* Other means like extractions of supernumerary teeth, occlusal equilibration, correction of minor malocclusion like developing cross bites undertaken at the right time, are useful parts of preventive orthodontics.

CONDITIONS TREATED AS A PART OF PREVENTIVE ORTHODONTICS IN THE DECIDUOUS DENTITION PERIOD

1. *Developing cross bites:* Minor procedures like occlusal equilibration and tongue blade therapy can be carried out well during the deciduous

dentition period. Other simple measures can be taken as a part of interceptive orthodontics mainly in the mixed dentition period. For example, removal of premature occlusal contacts by grinding the incisors could correct a pseudo CI-III anterior cross bite. Tongue blades can be used for treatment of simple, single anterior tooth cross bite. Developing posterior cross bites as a result of occlusal interferences, or pressure habits should be treated by removal of such occlusal interferences and by motivation, and counseling.

2. *Space loss*: Whenever there is a loss of proximal contact between the teeth as a result of proximal caries or premature loss of deciduous teeth, the mesial component of force may become active and cause mesial drifting, resulting in space loss from the arch length. When the deciduous molars are extracted prematurely, space is lost from the arch length due to rotation or tipping of the adjacent teeth. This would disturb the guidance of eruption of first permanent molars on one side and bicusps on the other side of extraction. When deciduous canine is lost prematurely on one side, then a midline shift could occur leading to a disto-lingual inclination of anterior teeth.

Space maintainers are used to maintain the space to guide the unerupted succedaneous teeth into their correct position in the arch. Space maintainers could either be removable or fixed, active or passive, functional or non-functional.

a. *Fixed space maintainers*

- Band and loop space maintainers
- Distal shoe space maintainer
- Lingual arch
- Nance palatal arch
- Transpalatal arch
- Bonded space maintainers

Band and loop space maintainer is a fixed, non-functional and passive space maintainer used mainly to maintain the space created by loss of deciduous first molar. The second deciduous molar is banded and a loop is soldered to the band. This loop spans the edentulous space and touches the distal surface of deciduous canine below the contact point. The loop is designed and rested on the tissue on both sides of the ridge with buccolingual width enough to permit the eruption of the underlying permanent first premolar (Fig. 4.1).

Modified distal shoe space maintainer is constructed when there is a premature loss of deciduous second molar to guide the eruption of first permanent molar. A radiographic assessment of the un-erupted



Fig. 4.1: Band and loop space maintainer on one side and crown and loop space maintainer on the other side

first permanent molar is made. The first deciduous molar is banded and a v-shaped wire soldered to the distal side of the band extends gingivally up to the distal side of the extraction socket of the second deciduous molar (Fig. 4.2).



Fig. 4.2: The distal shoe space maintainer

Nance palatal space holding appliance is mainly given when there is a bilateral loss of deciduous molars. Upper molars (deciduous second molars or first permanent molars) are banded bilaterally and wire is soldered on the palatal side of the bands and extends anteriorly into the hard palate 1 mm away from the mucosa. An acrylic button is fabricated on the wire anteriorly on the slope of the palate to provide resistance to movement of the appliance. It is a fixed, passive maxillary space maintainer used to preserve space created as a result of bilateral loss of deciduous molars. It could be combined with a habit breaking device fabricated on the acrylic button (Fig. 4.3).



Fig. 4.3: Nance palatal holding arch with palatal button

Bondable universal and instant space maintainer kits are also available. *Note:* Lingual arches and transpalatal arches are rarely used as space maintainers in the primary dentition. Hence, they would be discussed in another chapter on Interceptive Orthodontics carried out in mixed dentition period.

b. *Removable space maintainers* are basically acrylic plates with artificial teeth and wire clasps. These could be used in primary or mixed dentition, mainly, when there is loss of several teeth or when supra-eruption has started. They are also indicated in the anterior segment where the loss of teeth is affecting speech and esthetics (Fig. 4.4).



Fig. 4.4: Removable space maintainer

3. *Over retained deciduous incisors:* Permanent incisors should be assessed radiographically and accordingly, over retained deciduous incisors should be extracted as they impede the eruption of permanent teeth.
4. *Occlusal interferences:* There is an appearance of pseudo cross bites due to presence of occlusal interferences, which may cause a functional shift of the mandible to occlude in a position dictated by the cusps and affect the muscle balance. Such functional malocclusions affect the future

growth of cranio-facial structures and also, distort the alveolar structures. Hence, the preventive means include:

- Interfering cusps should be grinded.
 - Faulty occlusal restorations should be adjusted or replaced.
5. *Ankylosis of primary teeth*: Mainly, the mandibular primary molars get ankylosed and they impede the eruption of succeedaneous permanent teeth. Any delay in shedding of primary teeth should be assessed radiographically for detecting ankylosis and the tooth should be extracted.
 6. *Supernumerary teeth*: Supernumerary teeth, e.g. mesiodens between central incisors cause either delay in the eruption of related permanent teeth or cause rotations or displacements of these teeth. Hence, if supernumerary teeth are detected, they should be extracted prior to any orthodontic treatment.
 7. *Systemic disorders*: Hypophosphatasia, dentine dysplasias, scurvy, etc. might exhibit failure of periodontal anchorage and premature loss of primary teeth. Hence, systemic medication should be given to control the disorder on time to prevent the developing malocclusion.
 8. *Abnormal oral habits*: Habit can be defined as a constant practice established by frequent repetition. Oral habits are practiced in the oral cavity and are learned patterns of muscular contractions. Oral habits could be intentional, unintentional or functional. Common abnormal oral habits to be looked in a child are thumb sucking, digit sucking, lip biting, tongue thrusting, mouth breathing and bruxism.
 - a. *Thumb sucking or digit sucking*: If this habit persists beyond the second year of life, it should be controlled early to avoid deleterious effects on teeth and jaws. The habit could be a result of feelings of hunger, satiety or prolonged bottle feeding or other factors like emotional stress due to peer pressure, parental insecurity, etc. The degree of clinical problems associated with thumb sucking depends on the duration and frequency of the habit practiced. Usually, a child places thumb or digit between the teeth pressing lingually against the mandibular incisors and labially against the maxillary incisors. There is prolonged separation of jaws causing supra-eruption of posterior teeth. The buccinator muscle contracts during sucking, increasing cheek pressures against teeth. This leads to the following associated clinical problems:
 - Proclined maxillary anteriors
 - Retroclined mandibular anteriors
 - Anterior open bite
 - Constricted maxillary arch
 - Posterior cross bite.

This condition is treated with a preventive approach in the primary dentition period (Fig. 4.5).

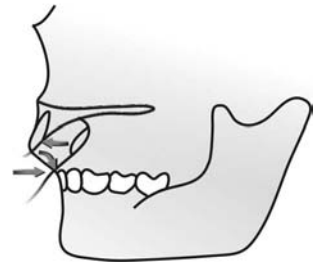


Fig. 4.5: Phenomenon of thumb sucking demonstrating the abnormal forces acting on the teeth

- i. Motive behind the habit should be diagnosed by taking proper history from the child as well as the parents.
- ii. If the child practices the habit only for a short duration when he is alone, parents should be advised to engage the child in his favorite hobbies or activities during this time. This would divert the child from practicing the habit.
- iii. If there is a feeling of insecurity in the child, counsel the parents to share his anxieties and to love and soothe the child.
- iv. Find out whether the child remains hungry and practices the habit. The child should be well fed to reduce this usage. Also, educate the mother to properly nurse the child.
- v. The flow of milk should be slow and steady through the nipple of the bottle in case of bottle-feeding. Physiological nipples with standardized hole size should be used (Fig. 4.6).
- vi. Use of pacifier would be helpful in a child whose behavior shows an urgent desire to indulge in thumb sucking.
- vii. The clinical features like open bite, due to thumb sucking, are first seen, usually, around 4 years of age. If the patient is motivated to drop the habit at this age, the malocclusion could be corrected on its own. But, if the habit persists beyond 6 years, the malocclusion would require treatment for its correction.
- viii. Clear explanation and motivation to the child by the dentist with a reward therapy would be helpful in encouraging the patient to discontinue the habit.
- ix. Use of means to break the pleasure of thumb sucking like applying a bandage on the thumb, putting a glove on hands, application of a bitter or non-palatable substance on the thumb, would dissuade the child from placing the thumb in the mouth.



Fig. 4.6: The nuck sauger physiologic nipple

Use of habit breaking appliances can be done during the mixed dentition period.

- b. *Tongue thrusting*: This is described as a forward placement of tongue between the anterior teeth and against the lower lip during swallowing. It is considered to be present as a result of retained infantile swallow or is considered as a transition phase between the infant and adult swallowing patterns. Prolonged bottle feeding or improper diet consistency could also attribute to the development

of improper swallowing habits. Larger tongue size, hyperactive orbicularis oris or inherent neuromuscular patterns lead to development of tongue thrust. Habitual mouth opening or open bite as a result of prolonged thumb sucking habit or skeletal open bite, favor the tongue to thrust anteriorly to form an oral seal (Fig. 4.7).



Fig. 4.7: Simple anterior tongue thrust with normal tooth contact in posterior region and anterior open bite

The following associated clinical problems are seen:

- Certain speech disorders like lisping, greater lip separation erratic mandibular movements.
- Proclined maxillary anterior teeth with spacing in between them and a constricted maxillary arch, retroclined mandibular incisors/anterior open bite with anterior tongue thrust.
- Posterior cross bite, posterior open bite and deep bite with lateral tongue thrust. Fig. 4.8 describes a complete tongue thrust (complex tongue thrusting).



Fig. 4.8: Complex tongue thrust with generalized open bite and absence of tooth contact in occlusion

It is very important to detect this deleterious habit early and treat it with preventive approach. Observe the tongue posture with lips apart in rest position of the mandible. For this, observe the tongue posture with lips apart in rest position of the mandible. Also, observe the tongue movements during swallowing and during speech.

Preventive approach of treatment

1. Functional exercises

- i. Ask the child to place the tip of the tongue in the rugae area of the palate for some time and then swallow. Similar exercise can be done with orthodontic elastic, which is held by the tongue tip against the rugae area of the palate. Ask the child to check mentally that the elastic is not slipped and then swallow, keeping the lips apart.
- ii. Ask the patient to occlude his molars, place the tip of the tongue on the rugae area of palate and then practice sucking.

- iii. Ask the child to pronounce as many words starting from 'S' or ask him to repeat the count from sixty to sixty nine. This would train to correct the position of tongue and train the correct swallowing patterns.
 - iv. Repeated whistling or gargling could be done to train the muscles.
2. *Guiding appliances*: Pre-orthodontic trainer with a tongue guard inhibits tongue thrusting and also trains the correct positioning of the tongue. Fixed palatal arch appliance with acrylic button placed anteriorly upon the rugae area can guide the correct positioning of the tongue.
- Habit breaking appliances can be given during the mixed dentition phase as an interceptive aid.
- c. *Lip biting*: This habit develops as a compensatory effect of difficulty in approximating the lips due to excessive over jet. It could be present in two main conditions:
- Along with open bite due to thumb sucking; to form an oral seal.
 - In class II div I malocclusion with excessive over jet, again to form an oral seal.

In this habit, the child keeps on wetting the lips with the tongue and then places the lower lip in the mouth, which is caught behind the upper anterior teeth.

The following associated clinical problems are seen:

- Constant pressure of the lower lip on the lingual aspects of maxillary incisors leads to proclination of these teeth.
- Constant lingual pressure of the lower lip on the mandibular incisors leads to retrusion of lower incisors with crowding.
- In severe practice, the lip itself becomes red and hypertrophic and the mentolabial sulcus becomes prominent.

Preventive treatment approach

Usually, appliances that reposition the lip away from the maxillary incisors are used as refraining measures during this phase. Ideal treatment is the correction of malocclusion, which by itself corrects this habit. Complete correction of malocclusion has to be done at a later stage. An oral screen or a lip bumper is used to refrain the lower lip, which also tones the lips.

Oral screen

A working bite is constructed and the labial and buccal surfaces of teeth are covered with acrylic with enough clearance between the enamel of teeth and the acrylic. This screen is made to rest in the labial vestibule of the oral cavity. A wire ring can be placed in the anterior region of the screen, which helps in the lip exercises.

Lip bumper

Usually, a semi-fixed lip bumper is used. The second deciduous molars (or first permanent molars) are banded with buccal tubes. A

labial screen is attached to wires, which are passed into the buccal tubes. This labial shield keeps the lower lip away and removes aberrant labial activity. The wire with the labial shield is kept labially at some distance from the labial surface of lower incisors. So, the incisors and the mandible are allowed to come forward (Fig. 4.9).

- d. *Mouth breathing*: It is the habit of breathing through the mouth instead of the nose. This habit develops mostly when there is insufficient passage for air through the nose. The patient almost always keeps his lips apart and breathes through the mouth. Deviated nasal septum, nasal polyps, enlarged adenoids or tonsils are some of the obstructive conditions leading to mouth breathing. Anatomically, short upper lip and habitual mouth opening also lead to the practice of mouth breathing.

The associated clinical problems are:

- Usually, these patients have a long narrow face with a collapsed upper arch due to hypertrophied lymphoid tissue and low set position of tongue to allow adequate airflow through the mouth.

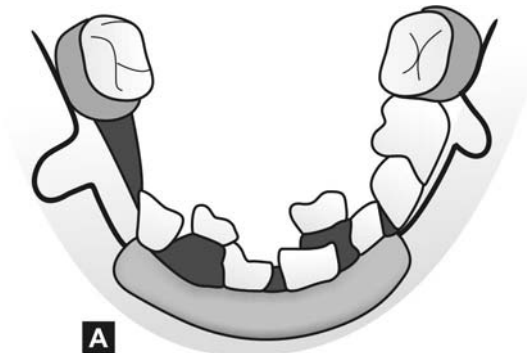


Fig. 4.9A: Diagrammatic representation of lip bumper appliance in the mouth

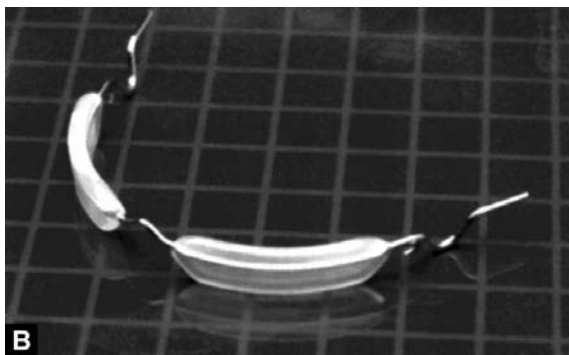


Fig. 4.9B: Cushioned lip bumpers with contoured lip pads for patient comfort
(Courtesy: Ortho organisers)

- Speech defects with a nasal voice tone.
- Parted lips, with short upper lip and a curled over lower lip.
- Gingiva is constantly exposed to air and so, is inflamed with a rolled out margin. Inter-dental papillae are enlarged and irritated and heavy calculus deposits might be present.

Treatment approach

- If a nasal or pharyngeal obstruction is suspected by the clinician, medical intervention and correction of the cause should be done by referring to the medical specialist.
- If it is a habitual practice, then correction should be done by introducing breathing exercises and lip exercises to the child. Deep breathing exercises with deep inhalation should be done in the morning or at night. Lip exercises, which stretch the upper lip to cover the maxillary incisors, should be introduced to the child. Also, consciously holding a disk between the lips and balancing it so that it does not drop would serve as a lip exercise.



Fig. 4.10: An oral screen with a labial ring for muscular exercise

Preventive appliance

The best appliance for this is an oral screen as it prevents air to enter through the mouth. Along with an anterior wire loop, it helps in lip exercises also. Initially, few holes are placed on the oral screen so that the habit of breathing through mouth is slowly tapered (Fig. 4.10).

- e. *Bruxism:* Bruxism is the grinding of teeth when the child is not chewing. The child could grind the teeth consciously or unconsciously both during daytime or night time.

Clinical features associated with this habit

1. Uneven shiny occlusal wear patterns due to occlusal and incisal attrition leading to pulp sensitivity and an acquired deep bite.
2. Tooth mobility and gingivitis due to occlusal trauma.
3. Jaw muscles are tender to palpation and fatigued due to hyperactivity of masticatory muscles.
4. TMJ disorders leading to jaw deviation arising due to functional occlusion.

Treatment approach

This should be first aimed at eliminating the causative factors such as occlusal discrepancies, functional contacts, emotional stress factors, over-enthusiasm, joint discomfort, etc.

- Grinding of involved cusp tips to bring occlusal equilibrium.
- Raising the acquired deep bite by placement of crowns on posterior teeth. This also relieves the increased muscle tonus.

- Custom made occlusal splints commonly named as 'night guard', which cover occlusal surfaces of all teeth. Impressions (both upper and lower) are taken and a vulcanized splint is fabricated on the mandibular cast.
- Relaxing muscle exercises, massage, or physiotherapy should be practiced.
- Periodontal treatment should be taken up to eliminate periodontal discomfort.
- Muscle relaxant drugs, anti-anxiety drugs should be prescribed as per requirement.
- Psychological counseling could be provided to decrease the emotional stress.

5

Interceptive Orthodontic Treatment

Interceptive orthodontics is defined as 'that phase of science and art of orthodontics employed to recognize and eliminate the potential irregularities and malpositions in the developing dento-facial complex'. This aims at intercepting and treating the minor problems present during the mixed dentition phase of the developing dentition, so that these problems become less complex and easy to treat at a later stage.

The most common problems, which can be intercepted are:

1. *Loss of space*: Space regaining procedures are done for progressive loss of space when there is premature loss of primary teeth. In addition to the segment of missing tooth, other factors like relationship of teeth to the denture base, transverse, sagittal dental relationships and space requirements, etc. should be collectively analyzed before starting these procedures. Diagnostic aids like periapical radiographs, model analysis and clinical assessment of the dentition and face are necessary.

Tanaka and Johnson analysis is a mixed dentition analysis, which is a simple analysis based on a formula:

Predicted width of maxillary un-erupted canine and premolar

$$= \frac{(\text{Sum of mesiodistal widths of mandibular incisors} + 11)}{2}$$

Predicted width of mandibular un-erupted canine and premolar

$$= \frac{(\text{Sum of mesiodistal widths of mandibular incisors} + 10.5)}{2}$$

The purpose of this mixed dentition analysis is to evaluate the amount of space available in the arch for succeeding un-erupted permanent teeth and the adjustments required to achieve this space.

Various Space Regainers

Fixed Space Regainers

- i. *Herbst space regainer (open coil space regainer)*: This is placed mainly to regain space lost as a result of early loss of 2nd deciduous molar by distalizing the permanent first molar that drifted towards the extraction space.

Appliance design

- Molar band of 1st permanent molar with molar tubes on the buccal and lingual of the band. Alginate impression with band is taken and the impression is poured with stone plaster after the band is seated in the impression.
 - U-shaped stainless steel wire is bent. This will fit passively in both the molar tubes on one side and adapted so that it contacts the distal surface of the premolar on the other side.
 - Open coil spring, which is 2-3 mm longer than the distance from the anterior stop to the molar tube, is slid on this wire and the band is cemented by compressing the coil spring.
- ii. *Hotz lingual arch*: This is a mandibular fixed lingual arch with U-loops to distalize the molars, which drifted into the extraction space.

Appliance design

- Molar bands contact on both the lower permanent molars with lingual molar tubes.
 - Lingual stainless steel wire contacts all teeth lingually and slides through the lingual molar tubes.
 - *Activation*: The posts in the passive position should be 1 mm distal to their passive positions over the lumen of their tubes, which forces the arch forward and molars backward.
- Note*: Firstly, X-ray evidence should show enough space between first molar and the un-erupted second permanent molar.
- iii. *Gerber space regainers*
- It is directly fabricated in the mouth to push the teeth drifted into the edentulous area from both sides.
 - Tooth distal to the space is bonded with the molar tube on both sides. U-shaped wire assembly is prepared with required bucco-lingual and mesio-distal dimension. An open coil spring with length 2 mm greater than distance from the anterior stop to the molar tube is slid on this wire. The springs are compressed and the wire assembly is fitted into the edentulous space by sliding the wires through the buccal tubes.
- iv. *Fixed sectional arch technique*: This can be used in cases where second molar is erupted.
- v. *Lip bumper*: This appliance is best used to regain space by bilateral tooth movement, distalizing molars and aligning lower incisors.

Appliance design

- Molar bands with buccal tubes on lower molars.
- Heavy labial arch with anterior acrylic flange not contacting the lower anteriors.
- *Activation*: Distalizing pressures can be achieved by bending U-loop in the labial arch wire just before it enters the buccal tubes (Fig. 5.1).

Removable space regainers

i. Helical spring space regainer

Design: A Hawley appliance with base of acrylic resin, labial bow for stability; Adams clasp on contra-lateral clasp molars. 0.6 mm wire helical spring with active arm towards the tissue in the mesial undercut of the molar.

- At a period of every 2 weeks, the springs should be activated to produce a distal force against the permanent first molars. Usually, 2 mm of distalization occurs in 2-4 months.

ii. Split block or split acrylic dumb-bell spring space regainer

Appliance design

- Lower Hawley appliance consists of acrylic block that is split bucco-lingually and joined by wire dumb-bell spring in the form of buccal and lingual loop (Fig. 5.2).
- The appliance is activated twice a month by spreading of loops of the spring and 3 mm of space is recovered by distalizing the lower molars.

iii. Sling shot elastic space regainer

Appliance design

- A wire elastic holder with 2 hooks, one on the middle one third of the lingual aspect of the molar to be distalized and the other on the buccal aspect of the molar.
- An elastic is stretched between the two hooks and produces the distalizing force; hence called sling shot appliance. The elastic should be changed every day.

iv. Jack screw/expansion screw space regainers: These are Hawley appliances with acrylic resin base, ball clasps, Adams clasps. This incorporates an expansion screw towards the edentulous area in such a way that opening the screw would expand the plates antero-posteriorly.

Activation: $\frac{1}{4}$ turn every week for around 2-3 months.

2. Developing anterior and posterior cross bites: Cross bites can be defined as a condition where one or more teeth may be malposed abnormally,

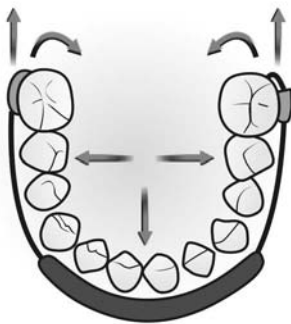


Fig. 5.1: Schematic representation of a lip bumper mechanism



Fig. 5.2: Split acrylic space regainer with a dumbbell spring

buccally or lingually with reference to the opposing tooth or teeth. Cross bites could be anterior or posterior, unilateral or bilateral. Cross bites could be true or functional in nature but cross bites if not treated early could lead to a skeletal malocclusion requiring corrective orthodontic treatment later. It would be easy and effective to treat cross bites in the mixed dentition phase when the permanent teeth have begun to erupt.

a. *Interceptive measures for anterior cross bites*

- i. *Occlusal equilibration*: Interfering incisal edges could be grinded and equilibrated, which might give appearance of functional class-III malocclusion.
- ii. *Tongue blade therapy*: This therapy is used to unlock a single anterior tooth in its early stage of eruption by placing the tongue blade 45° behind the tooth. If this is practiced for 2 hours daily for a total period of about two weeks, the developing single tooth cross bite can be corrected.
- iii. *Lower Catalan's inclined plane*: An acrylic inclined plane is contoured at 45° angle to the long axis of the lower incisor teeth and cemented to the lower teeth for correction of upper cross bite involving one or two teeth.
- iv. *Compomer inclined slopes*: An inclined slope of compomer can be directly bonded on the lower teeth in the patient's mouth for the correction of single tooth cross bite. Lower strength of compomer than composite is preferred since it can be easily removed when the treatment is over.
- v. *Removable appliance with 'Z' springs*: This is used for the correction of cross bite in upper and lower one or more teeth.
Acrylic design: Hawley appliance with acrylic resin base and very thin bite blocks is used to unlock the cross bites, with 'Z' springs on the lingual of the teeth to be pushed out. Adams clasps and ball clasps are used on the posterior teeth.
Appliance wear and activation: 24 hours wear by the patient is suggested. 1.5-2 mm activation of the spring every two weeks is done by the clinician.
- vi. *Hawley appliance with expansion screw*: An expansion screw is incorporated in the Hawley appliance anteriorly behind the segment in cross bite in such a way that opening the screw would expand the plates antero-posteriorly. The screw is activated ¼ turn every week and unlocking of cross bite is achieved by acrylizing thin bite platforms posteriorly.
- vii. *Metallic crowns on the upper tooth*: Reverse stainless steel crowns can be placed on upper incisor single tooth cross bites in which lower incisors are previously displaced labially.
- viii. *Fixed appliance with multi-looped A/W*: A 2 × 4 fixed appliance (involving 2 molars and 4 incisors) is recommended along with placement of multi-looped arch wires, which can be activated by stretching the inter-bracket span of the wire to correct the anterior cross bite.

- b. *Interceptive measures for posterior teeth:* Occlusal equilibrium: Sometimes, interferences in the cuspid areas on one or both sides may lead to bilateral dental cross bites in the mixed dentition. Usually, these are corrected by removing occlusal interferences in the cuspid areas.

Single tooth crossbite: Posterior unilateral single tooth cross bites are best corrected by use of 'cross elastics'. Brackets or buttons are bonded on the lingual surface of one tooth and buccal surface of the other. 'Cross elastics' from the lingual of one tooth to the buccal of the other in the affected area are used, which pit one tooth against the other and cause reciprocal tooth movement and thereby correct the cross bite. These elastics have a strong extrusive component, but the adolescent can tolerate to wear cross elastics for a short time as the extrusion is compensated by the vertical growth of the ramus. Elastic can be changed almost daily, and after the cross bite correction, the interferences of the cusps, which can rock the mandible, should be eliminated.

Bilateral posterior cross bite can be corrected by the following appliances:

- i. *Removable screw appliances for symmetrical expansion:* These are Hawley appliances with expansion screws incorporated to widen the arches. These screws work on reciprocal anchorage and widen the arches by slow expansion. The screw is turned through 90° at each activation 2 times a week because the periodontal membrane is not so thick in children.
- ii. *Rapid palatal expansion:* This is usually carried out with a HYRAX type screw in the late mixed dentition period to achieve bony movements in case of skeletal cross bite. The appliance consists of bands on upper permanent first molars and first premolars and wire arms soldered to the bands holding the hyrax screw in middle of the palate. The appliance is cemented in the mouth and one complete turn is opened rapidly and later, 1 complete turn is opened every day. The appliance produces heavy forces, which split the mid palatine suture and bring skeletal changes rapidly. The appliance brings rapid expansion in 2-4 weeks depending on the case and then, it should be left in the mouth passively for three months. Now, it can be accompanied by a buccal orthodontic bracket and wire assembly and a palatal retention by means of passive appliance where the screw can be covered with acrylic.
- iii. *Fixed lingual arches:* Upper W arch produces bilateral expansion. W arch is activated by opening the apices of 'W' 3-4 mm wider than the passive width and should be adjusted likewise before cementation.
Quad helix appliance: Quad helix again brings rapid maxillary expansion by orthopedic movement in children whereas in adults, it brings about dento-alveolar movements.

- iv. *Fixed orthodontic appliances*: This can be started in the late mixed dentition phase. The wire appliances bring about correction in individual tooth relationships as well as dental arch relationships. Cross elastics can be used with fixed orthodontic appliances.
3. *Crowding*: Crowding may be present in the early mixed dentition period. The permanent incisors are larger than their deciduous counterparts and this may have an impact on crowding in the pre-eruption stage of incisors.

****Upper lateral incisors are more palatally placed.**

****Lower incisors are lingually placed and are slightly rotated.**

The following steps should be taken to manage crowding in the mixed dentition period:

- Observe
- Proximal disking of primary teeth
- Extraction of teeth
- Referral for corrective orthodontic treatment.

Observe: When spaces are present in deciduous teeth, crowding less than 2 mm would correct on its own in most cases. Space analysis should be done and the child should be kept under observation by a regular recall.

Proximal disking of primary teeth: In the case of crowding of permanent incisors with space discrepancy of 3-4 mm only, disking the mesial surfaces of canines would make the space available for spontaneous correction by tongue pressure. When the space created by disking the canines is not adequate, mesial surface of deciduous first molar also can be disked. Disking can be done best by a proximal disking strip as it gives better control.

Extraction of teeth: The most recognized extractions to create space and to relieve crowding in mixed dentition are serial extractions, timely extractions, and Wilkinson's extractions.

- a. *Serial extractions*: Serial extraction is an interceptive procedure, which involves correctly timed and planned extractions of certain deciduous and permanent teeth in mixed dentition period to prevent malocclusion and allow alignment of permanent teeth. This is also called 'guidance of eruption'.

Indications for serial extraction:

- i. Class-I malocclusion with a straight profile and anterior crowding (space discrepancy—10-12 mm).
- ii. Lingually locked lateral incisors.
- iii. Crowded deciduous dentition without developmental spacing.
- iv. Midline deviation mainly due to unilateral canine loss.
- v. Abnormal root resorption of primary canine or premature loss of primary canines.
- vi. Disturbance in eruption sequence or anomalies like ankylosis, ectopic eruption, etc.
- vii. Crowded arches with flaring of teeth.

Case selection for serial extractions: The rules given below should be followed while selecting the case:

- Molar relationship should be CI-I bilaterally and the dental midline should coincide.
- The facial skeletal pattern should be favorable and balanced in all three planes of space.
- Convex profiles with severe crowding or skeletal CI-II, III should not be chosen for this.
- Cases with excessive spacing or congenital absence of teeth should not be chosen.
- Cases with discrepancy at least 5 mm in each quadrant.
- There must be neither deep bite nor open bite to select the case for serial extraction.

Main advantages of serial extraction:

- Reduces mechano-therapy and treatment time.
- Less pain and discomfort with very little or no loss of alveolar bone.
- Guides eruption of both erupted and un-erupted teeth.

Note: It is advisable to study the modes and take an OPG for the dental assessment before undertaking serial extractions.

Procedure:

Tweed and Dewel proposed sequences of extractions.

Dewel's method of serial extractions:

Teeth are removed in the sequence CD4.

- ** $\overset{C}{C} - | - \overset{C}{C}$ Deciduous canines are extracted to provide space for the alignment of the crowded incisors at the age of 8.5 years.
- ** $\overset{D}{D} - | - \overset{D}{D}$ Deciduous first molars are extracted to promote the eruption of first molar at the age of 9.5 years.
- ** $\overset{4}{4} - | - \overset{4}{4}$ The first premolars are extracted at a later date once the canines erupt between 10-12 years.

Tweeds method for serial extraction:

Sequence of extraction is DC4.

D means $\overset{D}{D} - | - \overset{D}{D}$; extracted at 8 years' age.

4 and C mean $\overset{4}{4} - | - \overset{4}{4}$ and $\overset{C}{C} - | - \overset{C}{C}$; extracted together when the $\overset{4}{4} - | - \overset{4}{4}$ crowns are just erupted.

- Timely extractions:* Only deciduous teeth are sequentially extracted (not the permanent teeth) at the time of eruption of their permanent succedaneous teeth. This is best carried out when the arch length discrepancy is between 4-9 mm.
- Wilkinson's extractions:* Wilkinson advocated the extractions of four first permanent molars between 8.5 and 9.5 years' of age, preferably little before the eruption of second permanent molars. This allows permanent second molar to assume normal relationship and

provides additional space for third molars and relieves crowding in the buccal segments.

Note: It is wise to select caries susceptible first molars for this extraction. Also, second premolars should not incline distally.

4. *Interception of oral habits:* Preventive approach of treatment of these habits has been discussed in chapter 4. Habit breaking appliances are given here as interceptive measures during the mixed dentition phase.

Habit breaking appliances for thumb sucking:

- Removable appliances used may be
- Hawley appliance with spikes
- Hawley's retainer with tongue guard
- Oral screen
- Simple acrylic plate

Fixed appliances:

- Rakes
- Upper lingual arch (transpalatal arch) with anterior crib device
- Quad helix

Maxillary lingual arch with a crib device soldered to it in the anterior region of the palate is soldered to molar bands bilaterally and is cemented into the mouth. This appliance makes it extremely difficult for the child to place the thumb or finger in the mouth. It also has a reminder effect on the child by removing the pleasure of sucking. In some children, for whom the crib is made, thumb sucking stops almost immediately and in others, the habit is dropped in a few weeks. The crib appliance should be left in place for 3-6 months after the habit has been dropped (Fig. 5.3).

Quad helix is a lingual appliance used for maxillary expansion. It also can serve as a habit breaking appliance while correcting the malocclusion by expanding the arch. This appliance acts as a reminder appliance and makes the placement of thumb very difficult.

Habit breaking appliances for tongue thrusting

Removable Hawley appliance with tongue spikes or tongue guards:



Fig. 5.3: Maxillary lingual arch with palatal crib

- Acrylic base over the entire palate contacting the lingual of the entire maxillary dentition, a labial bow to hold the anterior teeth.
- Stainless steel wire bent into long loops or spikes incorporated into the acrylic in the anterior region of the palate.
- Adam's clasp and ball clasps on the posterior teeth.
- Loops of the tongue crib limit the tongue behind it and this acts as a reminder appliance (Fig. 5.4).
- Usually, the habit drops in around 6 months of appliance wear and the loops should be cut one by one as the patient keeps wearing the appliance for another 3-6 months.
- Oral screen is a modified labial and buccal vestibular acrylic plate. An acrylic or a wire loop barrier between the teeth may be constructed to prevent tongue thrusting.

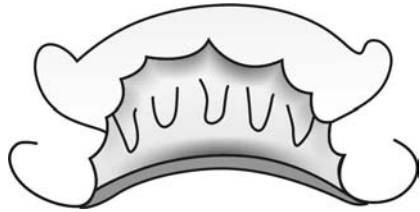


Fig. 5.4: Removable appliance with spikes bent into the acrylic for breaking the tongue thrust habit

Fixed habit breaking appliance:

First permanent molars are banded or crowned. 0.040 'U' shaped stainless steel lingual bar is adapted anteriorly at the level of gingival margin from canine on one side to the canine on the other side. Posteriorly, this wire is contoured and soldered or engaged to molar crowns or bands. Approximate 4 'V' shaped projections extending downwards are made with the arms of the crib soldered to the base. In the case of lateral tongue thrust leading to posterior open bite, the crib can be modified with lateral spurs to eliminate lateral tongue thrust and allow normal eruption of posterior teeth. About 4-9 months' of appliance wear is recommended.

Appliances for treatment of mouth breathing:

Mainly, mechanical appliances are used to correct the malocclusion, which forces or encourages mouth breathing practice. Mouth breathing habit is eliminated by the related malocclusion correction.

- Class-I dental and skeletal malocclusion with anterior spacing.
Oral screen appliance: This could be made of acrylic, pure latex or plexiglass.
- Class-II div I occlusion without crowding in children between 5-9 years.

Activator appliance: This corrects the malocclusion and thus develops the lip seal. Also, it acts as a habit breaking appliance by not allowing the airflow into the mouth.

- Class-III malocclusion: The child should be evaluated for a sufficient airway and then, a chin cap could be advised.

Habit breaking appliances for lip habit:

- Oral screen with a small anterior loop on the labial aspect.
 - Lip bumper.
5. *Skeletal malocclusion:* Generally, skeletal CI-II and CI-III malocclusions can be intercepted early by the use of *Myofunctional appliances*

Orthopedic appliances

- a. *Myofunctional appliances:* Change the position of the mandible and transmit forces generated by the stretching of the muscles or periosteum, through the acrylic and wire framework to the dentition and underlying skeletal structure. The best time to start myofunctional therapy is the late mixed dentition period as the advantage can be taken of the pubertal growth spurt. This active growth phase in mixed dentition period can be harnessed to optimize either the growth restraining effect or growth enhancing effect.

CI-II malocclusion may occur as a result of either increased maxillary growth or decreased mandibular growth or a combination of both. Appliances like bionator, activator, twin block, oral screen or Frankel's appliances can be successfully used for the skeletal correction. CI-III malocclusion, generally, requires enhancing the maxillary growth or retarding the excessive mandibular growth or a combination of both. Usually, Frankel III appliance can be successfully used for the same. Recently, CAD/CAM myofunctional appliances have been developed by various companies using the CAD/CAM techniques and flexibility and memory effects of silicone/non-thermoplastic polyurethanes. The appliances are soft and are shaped in the form of normal dental arches with channels for maxillary and mandibular teeth. Also, they have pre-molded labial bows and buccal screens in their design. These are easy to fabricate and are soft. Breakages are less as compared to the usual acrylic functional appliances.

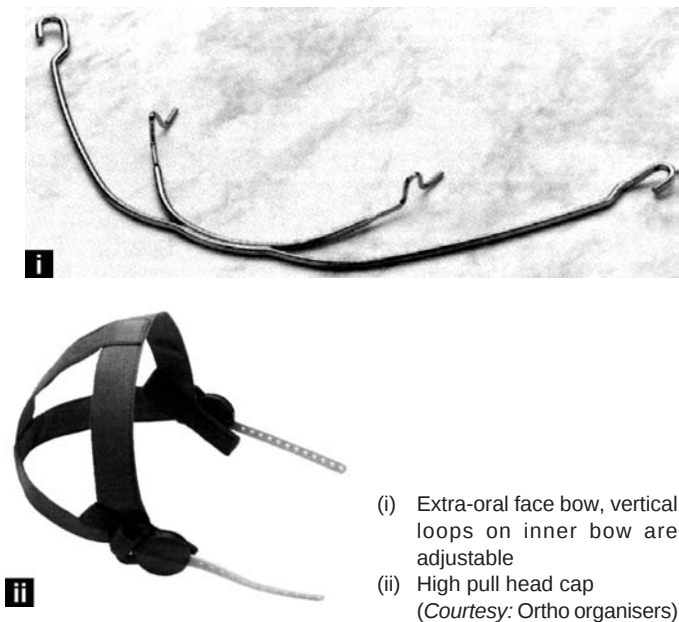
- b. *Orthopedic appliances:* These appliances apply external forces to the craniofacial structures for correction of facial skeletal deviation influencing the malocclusion. They use forces on the interrupted principle, which are more effective on the growing bone than the mature bone. If greatest structural changes are desired, pressures should be applied to the bone during a period of rapid growth. But, this would leave a longer period of 'bounce-back' and hence, long term control with appliance guidance would be indicated.

The systems by which orthopedic forces may be produced and delivered on the craniofacial bones (i.e. orthopedic appliances) include:

- i. Chin cups
- ii. Rapid palatal expanders
- iii. Orthopedic headgears
- iv. Pendulum appliances for molar distalization
- v. Face masks

Headgears: They are usually indicated in children with excessive maxillary horizontal growth and reasonably good mandibular skeletal morphology. They are indicated in children for early treatment of CI-II malocclusion as they help to distalize the maxilla and correct CI-II molar relationship. In adults, they are mainly used to conserve anchorage.

The headgear acts by compressing the maxillary sutures during the active growth period and thus, restrict the normal downward and forward growth of maxilla, allowing mandibular growth at the same time. It consists of a face bow that delivers the force, springs that generate force and connect the face bow to the anchor unit, and head cap, neck strap, which form the anchor unit. Duration of wear is at least 10 hours a day (Fig. 5.5).



Figs 5.5A(i) and (ii): Parts of the headgear assembly



Fig. 5.5B: Different types of headgears: High pull, medium pull and low pull

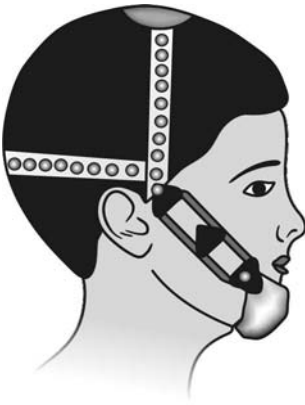


Fig. 5.6: Chin cup assembly

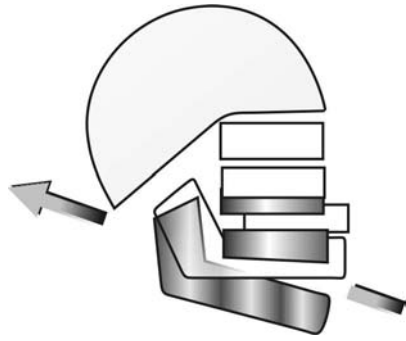


Fig. 5.7: Schematic representation of the force systems generated by chin cup therapy. Note that there is a downward and backward rotation of the mandible accompanied by an increase in facial height

Chin cap: It is mainly useful in the treatment of CI-III malocclusion due to protrusive mandible and relatively normal maxilla. Ideal patients for chin cap treatment are:

- i. Mild skeletal CI-III with ability to bring incisors end to end.
- ii. Short vertical face height.
- iii. Normally positioned or protrusive lower incisors.

The chin cap acts by redirecting the mandibular growth in a downward and backward direction and remodeling the mandible to improve the skeletal and soft tissue profile.

It is an extra-oral appliance and consists of chin cup, either hard or soft, custom made or preformed. Metal or elastic spring, which acts as a force module and provides the desired tension, levels on the chin cup and a head cap. This firmly seals on the postero-superior aspects of the cranium as anchorage. Commercially available chin cups like Unitek design, Hickham type appliances, are soft and elastic and are readily available.

Duration of wear: 9-10 years' of age would be the ideal age to start this therapy. A maximum of 12-14 hours a day of chin cup wear is advised (Figs. 5.6 and 5.7).

6

Corrective Orthodontic Treatment

Corrective orthodontics is that phase of orthodontics that recognizes the existing malocclusion and employs certain technical procedures to reduce or eliminate the problem and the attendant sequel. It aims at treating all malocclusions in the permanent dentition by repositioning almost all the teeth in the process to make the occlusion and esthetics as ideal as possible.

The best timing to commence corrective orthodontics is when all permanent teeth have just erupted and some amount of vertical and antero-posterior jaw growth is still remaining. Also, it can be done in adults as comprehensive treatment or adjunctive treatment.

A complete fixed orthodontic appliance followed by the needful therapy is required to accomplish corrective orthodontics. Fixed orthodontic appliances have active components, which generate tooth moving forces engaged in passive components fixed on the tooth surface and transmit these forces to the dento-alveolar structures. Active components are separators, arch wires, elastics, elastomerics, springs etc. Passive components are bands, brackets, lingual attachment, buccal tubes, lock pins, ligature wires, etc.

Fixed orthodontic appliances are far better than removable appliances as tooth movements in all three planes of space with a 3-dimensional control are possible. The appliance is best to achieve good inter-arch and intra-arch relationships aiming for ideal treatment or a wonderful camouflage. The mechanics of the treatment rests in the clinician's hands and the patient's cooperation is reduced.

Corrective orthodontics may include therapeutic extractions of teeth in two main circumstances

- i. Relief of crowding,
- ii. Correction of antero-posterior dental arch relationship aiming to improve esthetics, assure stability in the final result and increase functional efficiency.

The segment posterior to extraction is regarded as the resistance unit and segment anterior or mesial to it is regarded as the repositioning unit. The management of these 2 segments is different from one another in the same case and each case has different requirements to manage resistance to unwanted movement and brings the desired tooth movement.

Corrective orthodontics deals with the management of these problems and brings about desired movement resulting in closure of the extraction spaces. Teeth, muscles, and sometimes extra-oral areas like cranium and

occiput can be used as sources of anchorage to stabilize the resistance unit and prevent unwanted tooth movement.

Maximum anchorage cases are those cases in which the reaction forces should not move anchor teeth and the entire extraction space should be closed by distal movement of the active segment. *Minimum anchorage cases* are those cases in which the reaction forces should move the anchor teeth and the extraction space should be closed by a movement of active units and resistance units almost to the same extent. In *moderate anchorage cases*, the conditions between these extremes of anchorage situations could be included.

Usually, first premolars are preferred for extraction to obtain stable results because of their strategic location close to the anterior teeth as they can be retracted in symmetry and extraction spaces can be closed without much difficulty. Therefore, when all first premolars are removed, the prime objective is to achieve maximum anterior retraction in both upper and lower jaws. For lesser retraction in the lower jaw, upper first and lower second premolars should be extracted. Usually, 2nd premolar extractions are considered when the space discrepancy is less than 7.5 mm where the extraction space would not be closed by alignment of crowded anterior teeth and not much retraction of anterior teeth is required. Here, molars have to be moved forward more than 2.5 mm on each side losing anchorage.

First permanent molar extractions are considered when:

- these are badly decayed or majorly filled.
- there is skeletal open bite with a high mandibular plane angle.

Reduction of tooth structure posteriorly may reduce distal rotation of mandible and reduce the skeletal open bite. Also, least overall retraction occurs in the cases of 1st molar extraction as the space is closed by mesial migration of 2nd molars and 3rd molars erupt in the available space.

A variety of Edgewise appliances or the Begg's appliance can be used for the treatment with fixed orthodontic therapy. The **EDGEWISE APPLIANCE** introduced by Dr Edward H Angle in 1925 incorporates a method by which a rectangular arch wire is inserted into the bracket horizontally on edge. The Edgewise bracket has a 0.022 inch × 0.028 inch horizontally projecting slot with single or double tie wings (Fig. 6.1).

Anchorage preparation is done to prevent the mandibular and maxillary molars from drifting anteriorly in response to retraction of anterior teeth. The brackets are positioned and the arch wire is formed on an Edgewise arch former with a width dictated by the inner canine and buccal segment width in the original malocclusion. Then, first order, second order, and third order bends are incorporated in the arch wire (First order bends are in and out bends, 2nd order are mesiodistal bends and 3rd order bends are torquing bends).

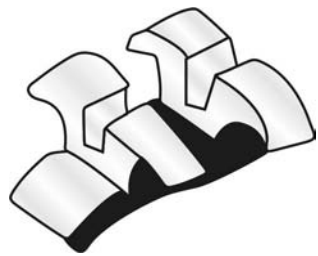


Fig. 6.1: The Edgewise bracket with a horizontal slot

Treatment can be divided in three stages:

- 1st stage : Alignment and leveling.
- 2nd stage : Correction of molar relationship
Closure of extraction spaces
- 3rd stage : Finishing by root paralleling at extraction sites
 - Adjustment of individual tooth positions
 - Torque of incisors
 - Correction of midline discrepancy
 - Finishing procedures to avoid relapse.

The **PRE-ADJUSTED EDGEWISE APPLIANCE (PEA)** (Fig. 6.2) was introduced by Lawrence Andrews in 1972. The bends, first order (in and out), second order (mesiodistal) and third order (torquing) are built into the brackets to achieve an ideal alignment of teeth. Various prescriptions (for in-out, tip and torque) are proposed by Roth and Andrews and various PEA systems are introduced. The first prescription was proposed by Andrews and the PEA appliance was called *straight wire appliance* as he advocated the placement of brackets on the Andrew's plane on which the mid-transverse plane of every crown in an arch falls when the teeth are ideally placed.

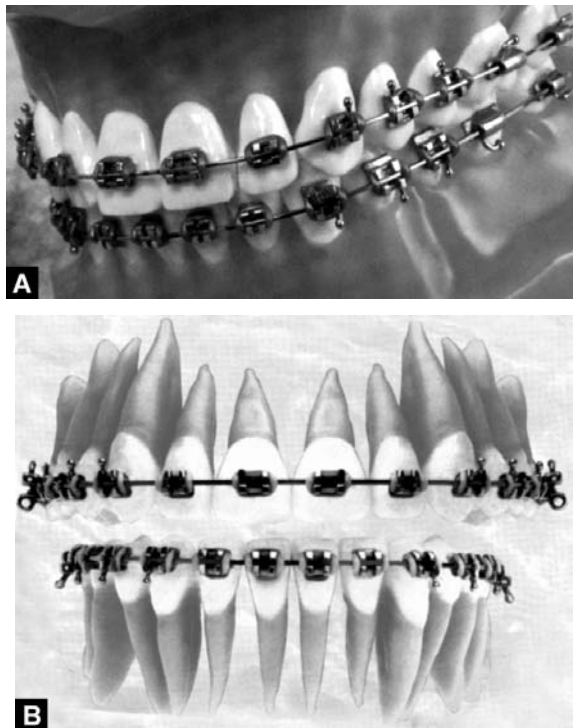


Fig. 6.2: A. The pre-adjusted Edgewise appliance. B. The pre-adjusted Edgewise system gives precision and control to achieve the Andrew's 6 keys of occlusion
(Courtesy: Ortho organisers)

The stages of management with PEA can be divided in the following sequential manner:

1. *Anchorage control*: Anchor units are controlled by using a transpalatal arch or Nance palatal buttons or wearing headgears. These prevent the maxillary molars from drifting mesially and also, maintain the transpalatal width.
2. *Leveling, aligning, and overbite controlling*: Light, round flexible wires are used for initial alignment. Ni-ti wires or braided steel wires can be used for initial alignment and 0.016 stainless steel wires are used for subsequent alignment.

Leveling can be achieved into two ways:

- Extrusion—relative intrusion.
- True intrusion.

Leveling by extrusion can be achieved with continuous arch wires having exaggerated curve of spee in the maxillary arch wire and reverse curve of spee in the mandibular arch wire. After initial alignment phase, 16 mil or 18 mil Ni-ti with exaggerated curve of spee in upper arch and reverse curve of spee in lower arch should be placed (Fig. 6.3). Sometimes, auxiliary leveling arch is used when heavier wires are required to complete the leveling of arches. Leveling is achieved by extrusion of one segment and relative intrusion of the other segment.

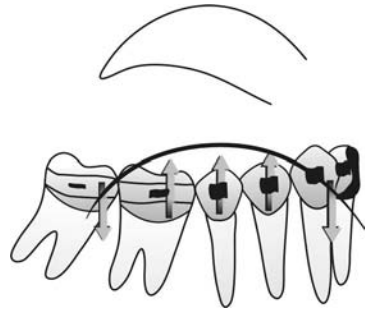


Fig. 6.3: Mechanism of deep bite correction with reverse curve of SPEE arch wire in a fixed orthodontic appliance

Leveling by intrusion is done by light continuous force directed towards the apex of the tooth in such a way that intrusion of one tooth should not be pitted against the extrusion of adjacent teeth. *Two methods are used to achieve this goal:*

- a. *Bypass arches*
 - i. 16 mil steel wire with anchor bends inserted in the molar tubes and by passing the premolar and canine are engaged in four incisors (Mulligan's leveling arch).
 - ii. Ricket's utility arches could be intrusion or extrusion arches depending on the type of bite, deep bite or open bite. Ricket's intrusion arch is 16 × 16 mil wires with step down bends between the first molar and the lateral incisors are used in 18 slot brackets (Fig. 6.4).
- b. *Segment approach*: After initial alignment, a rectangular wire 17 × 25 steel is placed in the bracket slots of second molar, first molar, and second premolar, which connects them into one stable unit and a fixed lingual arch should be placed for further stabilization. A resilient wire is placed in the anterior segment and the rectangular

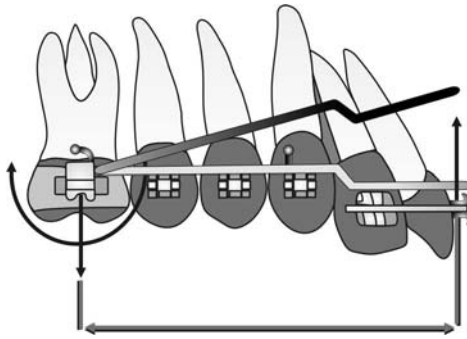


Fig. 6.4: The utility intrusion arch
(Courtesy: Ortho organisers)

depressing arch wire is tied beneath this resilient wire in the anterior segment.

c. *Overjet reduction and closures of spaces:*

This can be done in two ways:

- i. First, retract the canines and stabilize the posterior resistance units along with the canines and then, retract the incisors.
- ii. Retract the entire anterior segment en-masse along with the canines. This requires excellent anchorage control.

Overjet reduction and closure of spaces are accomplished with the help of changeable elastics or elastic modules with ligature ties, elastomeric chains or closed coil springs. This is part of *friction mechanics*. *Non-friction mechanics* like closing loops incorporated in arch wire close the spaces by pulling the end of the wire and activating the closing loops.

d. *Finishing and detailing:* Stiffer rectangular stainless steel wires with artistic bends are placed as finishing wires. Occlusal adjustment of individual tooth positions can be done. Cross elastics can be used for correcting minor midline discrepancies.

Retention appliance is a must after all corrections are achieved.

TIP EDGE APPLIANCES

It is a combination of straight wire appliance and appliance that uses differential forces. Hence, it is called *differential straight arch technique*. Tip edge bracket was introduced by Kesling and has the following design. The diagonally opposing covers of the conventional edge wise arch wire slot are removed and rotation wings are covered with a vertical rectangular slot to facilitate the placement of auxiliaries. This appliance can take advantages of light forces and differential anchorage as in Begg's technique and advantages of rectangular wire, which provides 3-dimensional control of each individual tooth.

The difference between the differential light wire appliance and this appliance lies in the use of rectangular wires in stage IV of this technique.

Finishing stainless steel wires, 0.019×0.025 size to 0.021×0.026 should be used.

BEGG'S ORTHODONTIC APPLIANCE

Dr PR Begg introduced this light wire technique and has been applying the principle of differential and optimum orthodontic force with the technique since 1938. Dr Begg has used 'differential' in the sense of its meaning in physics as the 'difference of two or more pressures or motions'. Optimum orthodontic force is that, which moves the teeth most rapidly with least discomfort to the patient and with least damage to the teeth and their investing tissues.

The Begg technique uses light and continuous arch wire and elastic and ligature forces and brackets that allow tipping to produce the most rapid movement of anterior teeth with least disturbance to the tooth investing tissues. These light forces, at the same time, produce very little mesial movement of the larger root molar anchor units. This is needed in the treatment of maximum anchorage cases where most of the spaces have to be utilized to move anterior teeth posteriorly.

In milder discrepancy cases, it is necessary to move the posterior teeth mesially to some extent towards the extraction spaces; then the anterior teeth can be made to resist being moved posteriorly, by preventing simple tipping back of the anterior crowns and rapidly moving anchor molars mesially by using powerful space closing elastics. This example explains the use of differential, optimum orthodontic forces in the Begg's technique.

The most important appliances and materials for the Begg technique are the Wilcock's round Australian arch wires, which have high resiliency and toughness, the ribbon arch type brackets with slots suitable for 0.016 arch wire, safety lock pins to hold the wire into the brackets, molar bands with round buccal tubes of 0.036 inch internal diameter and 0.250 inch length, the various auxiliaries springs like up-righting spring, de-rotation springs, torquing auxiliaries, elastics, elastic threads, coil springs lingual buttons etc. (Figs. 6.5, 6.6 and 6.7).

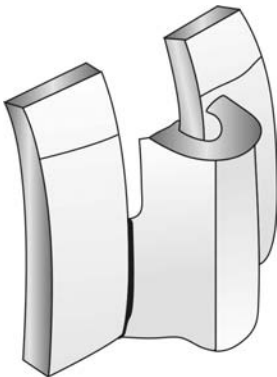


Fig. 6.5: The Begg bracket with a vertical slot

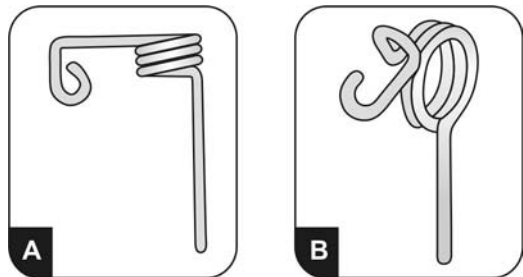


Fig. 6.6: A. Rotation spring; B. Up-righting spring
(Courtesy: ORMCO)

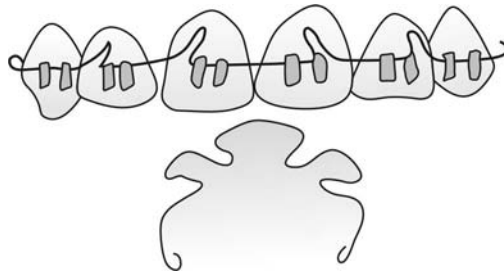


Fig. 6.7: The four spur torquing auxiliary for lingual root torquing in the Begg appliance

Treatment

The treatment is divided into three stages.

First Stage of Treatment

Goals to be achieved in Stage I are:

- a. Open (or close) the anterior over bite
- b. Relieve anterior crowding or close anterior spacing
- c. Overcorrect rotated canines and premolars
- d. Correct posterior cross bites
- e. Slightly overcorrect the molar relationship. 0.014 or 0.016 Ni-ti or looped Wilcocks wires can be used for initial alignment of teeth. After initial alignment, shift to plain 0.016 arch wires. CI-II elastics of 2-2.5 oz force levels are used in Angle's CI-I and CI-II malocclusion and these CI-II inter-maxillary elastics tip back the six upper anterior teeth. The upper arch wire with anchor bends, the lower arch wire with anchor bends, inter-maxillary elastics ligature wires should be placed together in one sitting as they act collectively to reciprocal advantage with each other.

Second Stage of Treatment

The goals to be achieved in stage II are to

- a. Maintain all corrections achieved during the first stage.
- b. Close remaining extraction spaces or any posterior spaces. 0.018 plain Wilcock arch wire with decrease in anchor bends and premolar offsets are engaged in the teeth. Three elastics are used on each side, 1 upper and 1 lower CI-I horizontal elastics, 1 CI-II inter-maxillary elastics to close the posterior spaces (Fig. 6.8).

Third stage of Treatment

Goals to be achieved in the third stage are:

1. To upright all teeth by moving the roots and putting all teeth in good axial inclination.

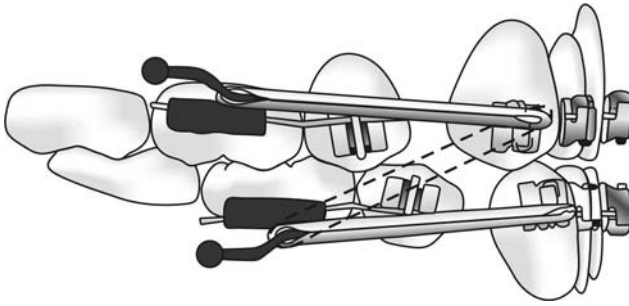


Fig. 6.8: Two horizontal space closing elastics and one inter-maxillary elastic applied at the second stage of treatment

2. To maintain all objectives achieved in stage I and II. 0.020 base heavy arch wire in maxillary arch and 0.018 arch wire in mandibular arch are used.

The maxillary arch wire with molar offsets is slightly constricted in its distal ends to counteract the widening effect of the maxillary torquing auxiliary. The mandibular arch wire with molar offsets is formed with a slight expansion in its ends to counteract the tendency for the mandibular anchor molars to tip lingually from the wearing of CI-II elastics. Up-righting and anterior lingual root torquing auxiliaries are engaged in the brackets to correct the inclinations of teeth. Light CI-II elastics can be continued. It may be noted that CI-III elastics are used in CI-III malocclusion.

Dr Begg has advised Begg's retention appliance at the end of all corrections.

LINGUAL ORTHODONTIC APPLIANCES

The main objective to use a lingual orthodontic appliance is to make the orthodontic treatment more esthetic particularly chosen for the adults. This could either be:

- i. An Edgewise lingual appliance
- ii. Or the light wire lingual appliance.

There are certain solutions for the difficulties encountered by the lingual placement of appliance. These are:

- a. Indirect bonding technique for correct bond placements.
- b. Use of inclined planes or bite plane to restrict occlusal interferences and frequent bracket failures.
- c. Use of brackets with smooth exterior surface to reduce tissue discomfort and speech difficulties.

At the end of the treatment, fixed permanent retention is a must.

Corrective orthodontic treatment could be either comprehensive orthodontic treatment or adjunctive orthodontic treatment.

Comprehensive Orthodontic Treatment

The treatment can be done with a complete fixed orthodontic appliance that aims at maximum improvement of esthetics, occlusal function and stability and requires more than six months for its completion. Comprehensive treatment can be done in adolescents where eruption of all permanent teeth has taken place. It can also be done in young adults (20-35 years of age) who desired but did not receive the treatment when younger. Comprehensive treatment in these adults is almost similar to the treatment in adolescents but special considerations have to be kept in mind in their case. These are:

- a. Motivating factors and psychological reactions towards the treatment are different. Expectations could be more.
- b. Increased susceptibility to periodontal disease and possibility that active periodontal disease could be reason for seeking the treatment.
- c. TMJ pain and discomfort could be a reason for seeking orthodontic treatment.
- d. There is lack of any small amount of growth, which makes tooth movement more difficult.

So, the following precautions must be taken in an adult patient for comprehensive treatment:

- They should be counselled to accept the appliance positively and keep their expectations as realistic as possible.
- When periodontal needs are the motivating factors, initial periodontal therapy should be done to bring the periodontal disease under control and then, orthodontic alignment of teeth should be taken up to improve occlusal relationships. Definitive periodontal and restorative treatment should be given later. Orthodontic forces should be kept at an absolute minimum because reduced area of periodontal ligament attachment means higher pressure in the periodontal ligament from any forces.
- As there is no compensatory growth benefit, all unwanted extrusions should be controlled by keeping the forces as light as possible by segmental arch technique and use of reinforced anchorage.
- TMJ dysfunction and/or pain might be reasons for visiting an orthodontist. These patients could have a practice of bruxing and clenching, background of emotional stress or a history of facial trauma. On orthodontic examination, these patients might exhibit some occlusal and facial asymmetry, pain on palpation of the joint, noises such as clicking and crepitus on movement. Radiographic assessment might be needed to detect the skeletal morphology. Specialized radiographs like panoramic X-ray, tomograms, lateral cephalograms, frontal cephalograms submental vertex cephalograms can be taken to detect the skeletal etiology.

Orthodontic treatment with fixed appliance should be least invasive along with the use of repositioning splints. Asymmetric

extractions could be done to balance the asymmetry and occlusal equilibration at the end of the fixed appliance therapy is a must. Sometimes, surgical intervention might be needed along with orthodontic treatment.

Adjunctive Orthodontic Treatment

It is the treatment with partial fixed appliance, which aims at facilitating other dental procedures necessary to control the disease and restore function and can be completed in less than six months' time. This adjunctive treatment is mainly sought by older adults who have other dental problems and need orthodontic treatment to meet specific goals that would make control of dental disease and restoration of missing teeth easier and more effective. This treatment may be used to reposition drifted teeth, improve periodontal health, position the teeth so that other occlusal forces are transmitted along the long axis of teeth.

Some procedures that are followed as part of adjunctive orthodontic treatment are:

1. *Repositioning or up-righting teeth drifted towards extraction site so that fixed partial dentures or implants can be provided.* For example, when a first molar is lost and 2nd and 3rd molars drift mesially into this space, it is better to extract 3rd molars and upright 2nd molar and 2nd premolars. For this, the involved quadrant should receive fixed orthodontic appliance from canine to the tipped 2nd molar.

- The tipped molar should receive a twin bracket with a convertible cap and a gingivally placed auxiliary tube. (Choice of appliance is made depending on the skill of the clinician but PEA appliance is most suitable for adjunctive procedure).
- The initial bracket alignment should be achieved by placing a light flexible wire Ni-ti (Nickel-titanium) or braided stainless steel wire from molar to canine.

- This is replaced by stiffer wire after the initial alignment. A helical up-righting spring should be placed in the auxiliary molar tube and activated by stretching the mesial hook and engaging it over the stabilizing wire (Fig. 6.9).

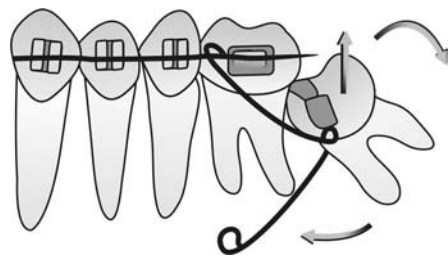


Fig. 6.9: Mechanism of molar up-righting spring

- After major up-righting is achieved by the use of up-righting spring, the spring can be removed and a compressed coil spring may be used on a round wire to complete molar up-righting and close the remaining spaces in the premolar region.

→ Ideally, a fixed bridge should be placed within 6 weeks after up-righting is achieved. If an implant is indicated, a passive wire, 19×25 , should be left for a short period in the brackets.

2. *Forced eruption to obtain good access for endodontic and restorative procedures or reduce pocket depth in teeth with horizontal oblique fractures, pulpal problems, caries and periodontal problems.*

Controlled extrusion should be done to obtain a good crown root ratio. Preliminary endodontic or periodontal treatment should be done earlier to relieve symptoms and a definitive treatment should be done after the tooth is extruded.

- The adjacent teeth are bonded and a heavy stabilizing wire 19×25 is placed. A post core with temporary crown and pin can be placed on the tooth to be extruded and an elastomeric module is used to attach it to the arch wire.
 - Then loops in a flexible rectangular wire can be employed for quicker extrusion. 4-5 mm of extrusion can take place in around 4 weeks.
 - Stabilization should be done with a passively fit rectangular wire and gingivoplasty can be performed to improve gingival contour.
3. *Correction of cross bites that cause functional problems, occlusal trauma and make periodontal, restorative and prosthetic treatment difficult.*
 4. *Alignment of anterior teeth for facilitating restorative and periodontal procedures is done by correction of rotations, crowding, spacing, lipping of teeth. Orthodontic alignment of teeth improves access and permits placement of well-controlled restorations and improves the embrasure form.*

Molars are used for anchorage and brackets are bonded on anterior teeth.

Initial alignment should be achieved with light flexible round wires, springs, elastic threads, elastomeric modules, ligature wire etc. When this is done, stiffer round or rectangular wire can be used to complete alignment.

Thus, a suitable orthodontic appliance and technique can be chosen for corrective orthodontic treatment. The treatment must be discontinued gradually using suitable means of retention. The type of retention to be used should be analyzed in the original treatment plan. In adults, generally fixed permanent retention or bonded composite splints is used as relapse is more common. Prosthetic and restorative rehabilitation can be used as permanent retention after adjunctive orthodontic treatment. In children, removable retention appliances can be used and should not be abandoned until growth is completed.



Surgical Orthodontic Correction

Surgical orthodontics is that phase of orthodontics that employs surgical procedures in conjunction with orthodontic treatment to facilitate correction of malocclusion by orthodontic techniques, to correct severe dentofacial problems, to stabilize and retain post-orthodontic results. Thus the objectives for surgical orthodontics are:

1. To perform related surgery as an adjunct to orthodontic treatment to aid in the correction of malocclusion.
2. To perform surgical operations to correct severe dentofacial irregularities where neither growth modification nor camouflage can offer good post-treatment result.
3. To make surgical intervention to help stabilize post-orthodontic treatment results and to prevent its relapse.

Thus, the cases where such objectives have to be achieved, successful management requires a coordination of orthodontic and surgical treatment done by a team of orthodontist and oral surgeon. Usually, preliminary dental corrections are done before surgical intervention and the teeth are positioned in best relationship to the individual skeletal components. Following surgery when healing has taken place, definitive orthodontic treatment can be commenced again to refine the occlusion. Stabilization of the results achieved by this interactive approach can be best provided by passively fit rectangular wire in the Edgewise appliance.

The following surgical procedures can be performed either in soft tissues or in the hard bony tissues as surgical aids to orthodontic treatment:

1. *Surgical aids to orthodontically position un-erupted teeth*
Permanent teeth could remain un-erupted due to
 - a. *Prolonged retention of ankylosed or submerged deciduous teeth*
Procedure: Surgical extraction of these deciduous teeth would facilitate eruption of succedaneous permanent teeth.
 - b. *Soft tissue or hard tissue impediments in the path of eruption.*
 - * *Presence of scar tissue after premature loss of deciduous teeth or after surgery in the area of erupting teeth.*
Procedure: Surgical exposure of un-erupted teeth by removing the dense tissue over the crown.
 - * *Congenital fibromatosis:* The entire gingiva is hypertrophied with its localized over growth.
Procedure: Gingivectomy and bone removal to facilitate eruption done within one year after the usual eruption time of teeth.

- * *Presence of eruption cysts and dentigerous cysts:* Eruption cyst develops due to enlargement of a follicle as a result of haemorrhage as the erupting tooth nears the surface. It is fluctuant and bluish in color.
Procedure: Excision of the involved gingiva facilitates eruption of teeth. Enucleation or marsupialization should be performed for eliminating dentigerous cyst.
- * *Presence of odontomes and un-erupted supernumerary teeth in the path of eruption:* Confirm their presence and location with intra-oral X-rays.
Procedure: The involved inter-dental space should be exposed by a vertical incision. Slow speed cutting with a bur is preferred to remove the dense alveolar bony tissue or to gain access around the un-erupted supernumerary tooth. After removing the supernumerary tooth or bony tissue, wound should be closed with inter-positioning sutures.
- c. *Tooth becoming impacted or interference in eruption due to interfering position of the adjacent teeth:* Tooth that is un-erupted could be either in a favourable position for eruption or in an unfavorable position for eruption.
 - *Un-erupted tooth in a favorable position:* The un-erupted tooth is in a fairly good position but the adjacent teeth might be hindering its eruption. This is most commonly seen in the case of maxillary canines, mandibular second premolars and third molar.
Procedure: Required space should be created by extraction of the hindering adjacent tooth or a tooth other than the one immediately adjacent to the impacted tooth. Any bony partition between the crown of un-erupted tooth and the extraction socket should be surgically removed. The underlying tooth can be allowed to erupt and then, positioned orthodontically.
 - *Un-erupted tooth in an unfavorable position:* Un-erupted teeth are impacted against adjacent teeth in such a manner that even if space is created for their eruption, the tooth would not erupt normally. This is most commonly encountered in maxillary canines and third molars.
Procedure: The tooth should be surgically exposed first and then orthodontically positioned. In case, orthodontic repositioning is not possible, surgical repositioning or transplantation of the tooth can be done.

SURGICAL EXPOSURE OF UN-ERUPTED TEETH

Impacted 3rd molars should be surgically extracted before they give rise to problems in the orthodontic treatment. We shall discuss about surgical exposure for un-erupted maxillary canines. The best time to surgically expose the tooth is, generally, within 1 year after the time of its normal eruption.

- * *Localization* of the un-erupted tooth is the first step towards the

procedure. It can be done clinically but radiographic assessment and confirmation is a must.

- Clinically, a bulge could be palpated in the area of the un-erupted crown. The inclination of the adjacent lateral incisor crown can reflect the position of un-erupted canines. If the canines are labially positioned, the lateral incisor crowns could be proclined as the crowns of un-erupted canines could be overlying on the roots of lateral incisors.
- Radiographically, periapical radiographs and occlusal views are a must. Lateral skull views (orthopantomograms) can be sometimes taken for IOPA application of tube-shift technique to determine whether the canine is placed buccally or lingually.

Surgical Procedure for Exposing a Palatally Placed Canine

A cruciform incision is made over the estimated position of the canine under LA or GA (Fig. 7.1). Soft tissue flaps are raised and excised. The bone overlying the crown is removed with a bibevel bur in a slow speed hand piece as this would not cut the enamel of the crown and a groove of 2 mm is made around the un-erupted crown. When the crown is exposed, the area should be irrigated well and the bleeding should be controlled. An orthodontic bracket can be directly bonded or banded at this time. A traction ligature wire can be tied to this bracket and extended up to the arch wire. Postoperatively, sufficient eruption of the tooth would occur spontaneously and the tooth can be guided into proper eruption by the traction ligature wire tied to the arch wire. Placement of bracket at the time of surgical exposure is advised as it would guide the tooth eruption and prevent re-exposure of the crown due to in-growth of surrounding soft tissues postoperatively.

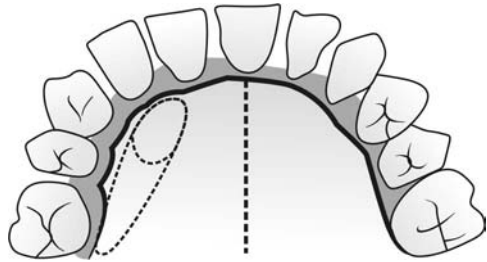


Fig. 7.1: Palatal approach to palatally impacted with palatal incision along the free gingival margin

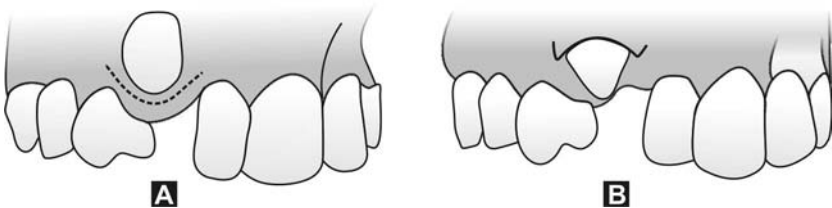
Surgical Procedure for Exposing a Labially Placed Canine

Here, excision of tissue is not preferred as it can result in a zone of non-keratinized gingiva around the cervical line and can lead to periodontal disease. Instead, a semi-lunar incision is made below the estimated level of the crown in the attached gingiva and an apically positioned muco-periosteal flap is reflected. After the crown is exposed, the margin of the flap is sutured near the cervical line providing a collar of attached gingiva (Fig. 7.2). An orthodontic bracket is directly bonded and a traction ligature

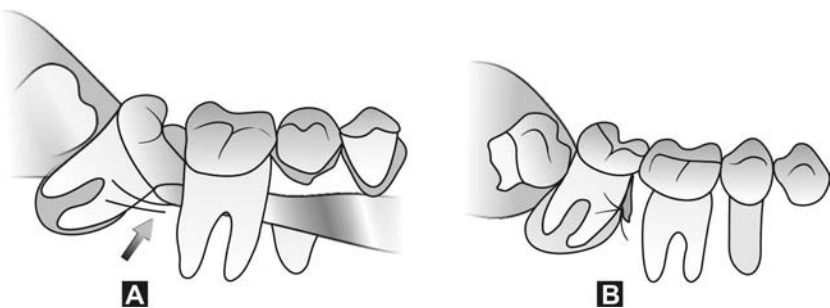
wire from this bracket is tied to the arch wire. Immediate traction is recommended as it enables control of tooth even if it gets covered with mucosa. Other impacted teeth like mandibular second premolars would require the same principles of localization, surgical exposure and orthodontic traction guiding it to eruption.

Surgical Repositioning and Transplantation

This is done when placement of an orthodontic appliance is difficult. Teeth, most frequently repositioned, are mandibular and maxillary second molars, mandibular and maxillary second premolars and maxillary canines. This should be attempted mainly when root formation is not complete as the teeth can tolerate movement without damaging the vitality of pulp or damaging the periodontium. If the root formation is complete, it is best to bodily reposition the tooth and then, treat it endodontically. The overlying mucosa is excised and sufficient bone is removed occlusally, distally and buccally to the crowns so that the socket would be able to accommodate the tooth. Tooth is gently tipped or bodily moved with an elevator into correct alignment and inter-proximal sutures are placed (Fig. 7.3). Autogenous transplantation can also be carried out for misplaced maxillary canines provided enough space is there in the arch.



Figs 7.2A and B: **A.** semilunar incision is made below the level of the crown of a labially positioned maxillary impacted canine in the attached gingiva. **B.** A mucoperiosteal flap is elevated, its margin is sutured near the cervical line, and the crown is exposed for bracket placement



Figs 7.3A and B: **A.** An un-erupted mesially drifted 2nd molar is being surgically repositioned by an elevator; **B.** Second molar is repositioned and the inter-proximal suture is placed to adapt the gingiva to the new tooth position

THERAPEUTIC EXTRACTIONS FOR CREATION OF SPACE

Sometimes, an orthodontic decision to extract healthy erupted premolar or molar teeth is taken to gain adequate space needed to align the teeth.

LABIAL FRENECTOMY FOR DIASTEMA CLOSURE

A labial frenum is a fold of mucous membrane that attaches the lips to the alveolar mucosa, gingiva, and the underlying periosteum. An anterior diastema can be caused or prevented from being closed if the frenum is thick, short fibrous and is attached too close to the marginal gingiva. So, a surgical procedure called frenectomy should be done to eliminate the abnormal labial frenum and correct the diastema between maxillary central incisors by removing the obstruction to approximate these teeth by fixed appliance therapy.

Frenectomy

It is the complete removal of frenum including its attachment to the underlying bone. The best time to perform frenectomy is during the orthodontic treatment and not before or after the orthodontic treatment. This has been discussed in a chapter on “Treatment of midline diastema” later in the text.

Procedure

- i. The area should be anesthetized and the frenum should be engaged with a hemostat inserted to the depth of the vestibule.
- ii. Incisions should be made along the upper surface and under surface of the hemostat.
- iii. The triangular resected portion of the frenum should be removed with the hemostat. This would expose the underlying fibrous attachment to the bone.
- iv. A horizontal incision should be made to separate the fibers.
- v. The operating area should be cleaned and the bleeding should be controlled.
- vi. Sutures should be taken and the residual defect on the gingiva should be covered with a periodontal pack.

GINGIVECTOMY AND GINGIVOPLASTY DURING AND AFTER ORTHODONTIC APPLIANCE THERAPY

Sometimes, supra-bony gingival pockets could be formed during the treatment of crowded teeth with brackets on them, which are difficult to clean. The enlarged gingival pockets harbor local irritants and also, obscure accessibility to the appliance. Hence, it becomes essential to eliminate the diseased gingiva during the orthodontic treatment. Gingivectomy is the surgical procedure performed to excise the gingiva and remove the diseased tissue and local irritants, thus creating a favorable environment for gingival healing and restoration of a physiological gingival contour.

Procedure

- i. The area should be anesthetized and the pockets should be marked in several areas so as to outline its course on each surface.
- ii. An incision should be started apical to the points marking the course of the pockets and directed coronally to a point between the base of the pocket and the crest of the bone. The incision should be beveled at approximately 45° to the tooth surface and should pass completely through the soft tissue to the tooth.
- iii. The gingival margin should be detached at the line of incision.
- iv. The field should be cleaned and granulation tissue and some calculus remnants should be removed. Then, the periodontal pack could be placed. Gingivoplasty is done in the absence of pockets with the sole purpose of re-contouring the gingiva after orthodontic treatment to provide the natural scalloped marginal outline of gingiva and eliminate gingival clefts and craters. It may be best accomplished with rotary coarse diamond stones or electro-surgery. Re-contouring the gingiva after orthodontic treatment is complete, gives an excellent finished look to the case and preserves the tissue integrity.

PERICISION TO CONTROL RELAPSE OF DE-ROTATED TEETH

Supra-crestal gingival fibers of an orthodontically de-rotated tooth undergo re-adaptation very slowly and the elastic recoil of these fibers is a major cause of relapse. Thus, if the supra-crestal fibers are sectioned when the teeth are held in the new correct position and allowed to re-attach at the new relaxed position on the root surface, then the tooth would be stabilized in the new position.

Procedure

Circumferential supra-crestal fibrotomy (CSF): The area should be locally anesthetized. No. 11 knife should be passed through gingival sulcus up to the crest of alveolar bone and cuts should be made inter-proximally on each side of rotated tooth along the labial or lingual gingival margin.

Papilla split technique: An incision is made in the center of the gingival papilla separating it from below the margin to 1-2 mm below the height of the bone. These procedures are done at the end of the finishing phase of the treatment before the appliance removal and beginning of the retention phase.

CORTICOTOMY FOR SHORTENING THE DURATION OF APPLIANCE THERAPY**Indication**

Alignment of maxillary anterior teeth in young adults.

Procedure

Vertical cuts are made with a bur on either side of each tooth through both the cortices a little away from the roots and the apical ends of these cuts are joined by horizontal cuts through the compact bone only. After a rest period of 2-3 days, orthodontic appliance can be fixed and teeth can be moved rapidly as corticotomy leaves the teeth to be aligned supported by cancellous bone.

ORTHOGNATHIC SURGERY FOR CORRECTION OF VERY SEVERE DENTOFACIAL PROBLEMS

For non-growing patients with dentofacial irregularities, usually, camouflage is done. Here, the malocclusion is corrected by conventional orthodontics to position the teeth in the correct relationship to their respective bases and the upper and lower arch relationship is co-ordinated in such a way that the skeletal discrepancy is camouflaged and esthetics is not compromised. For very severe dentofacial problems in non-growing patients where camouflage would worsen the condition, combined surgical orthodontic treatment is indicated. This combined approach highlights the exact nature of skeletal deformity and subjects it to surgery to bring esthetically pleasing and stable results. This combined treatment should ideally follow the given sequence with the given time estimation:

- i. Pre-surgical orthodontics —3-12 months depending on the severity of individual problem.
- ii. Surgery and hospitalization—3-8 days.
- iii. Observation, rest and surgeon's care—3-8 weeks.
- iv. Post-surgical orthodontics—3-6 months.

PRE-SURGICAL ORTHODONTICS

Objectives

- i. To relieve crowding, close spaces, correct rotations, and prevent its relapse tendencies.
- ii. To remove gross occlusal interferences and eliminate dental restrictions imposed for surgical jaw correction.
- iii. To reduce the operating time and surgical morbidity.
- iv. To position the teeth in an ideal relationship to their respective bases and allow maximum surgical correction.
- v. To allow easy post-surgical orthodontic finishing and detailing.

Choice of Teeth for Extraction for Pre-surgical Orthodontic Cases

It is different than camouflage cases. Here, for skeletal CI-II malocclusion, teeth should not be extracted in maxillary arch or 2nd premolars could be extracted if little space is needed. This is done to prevent over retraction of maxillary anterior teeth, which compromise the mandibular advancement. Lower 1st premolars could be extracted in the mandibular arch for leveling

the arch form and reducing anterior proclination. For skeletal CI-III malocclusion, extraction pattern is of reverse nature. Extraction of upper 1st premolars could be done to correct proclination of upper anterior teeth. Extraction of lower 2nd premolars could be done to prevent over retraction of lower anterior teeth after surgery.

Choice of Orthodontic Appliance for a Pre-surgical Orthodontic Case

Fixed pre-adjusted Edgewise appliance with '0.022' slot bracket systems would be an ideal appliance for pre- and post-surgical tooth movement and for stabilization during and after surgery.

- All the molars should be banded and should have integral hooks in their brackets for surgical stabilization and intra-arch elastic attachments.
- In the planned osteotomy site, it is advisable to tip the brackets on two adjacent teeth so that a straight wire would cause the desired root divergence.

Pre-surgical arch wires for alignment and leveling

- 0.010, 0.012 plain Australian Wilcock wires for initial alignment.
- 0.014, 0.016, 0.018 coaxial wires for relieving crowding.
- 0.014, 0.016, 0.018, 0.016x0.022 Niti wires for leveling and unraveling crowding.

Stiffer rectangular wires should be placed after alignment and leveling is achieved.

Precautions to be taken during Pre-surgical Orthodontic Treatment

- i. Orthodontic expansion should be limited to 2-3 mm per side as excessive buccal tipping would cause elongation of the lingual cusp, which in turn, would cause interference during post-surgery.
- ii. Avoid closing anterior open bite pre-surgically because of its adverse relapse tendencies. No intrusive mechanics should be used in anterior region and no posterior extrusive mechanics should be tried. Opening or closing of bite should be attempted during the surgical phase.
- iii. Segmental orthodontics should be used for leveling reverse or accentuated curve of spee.
- iv. Periapical X-rays of planned osteotomy region should be taken and if the roots of two adjacent teeth are convergent, they should be made divergent to allow placement of the osteotomy cuts.
- v. Towards the end of pre-surgical phase, a stabilizing passive rectangular wire with lugs between teeth should be placed 3 weeks prior to surgery. This would prevent any further tooth movement and enable the fit of occlusal splint at the time of surgery.
- vi. Models and photographs should be taken before fixing the stabilizing arch wires and one set should be handed over to the surgeon for mock surgery (i.e. model surgery).

In mock surgery, model is cut exactly similar to the surgery and observed for the movement of teeth and osseous segment. Problem areas are

redetected and reevaluated. Then, orthognathic surgery is performed by the maxillofacial surgeon as per the combined decision taken by him and the orthodontist.

SURGICAL PHASE

The patient is hospitalized after the pre-surgical orthodontic phase and the chosen orthognathic surgery is performed by the maxillofacial surgeon.

Orthognathic Surgery

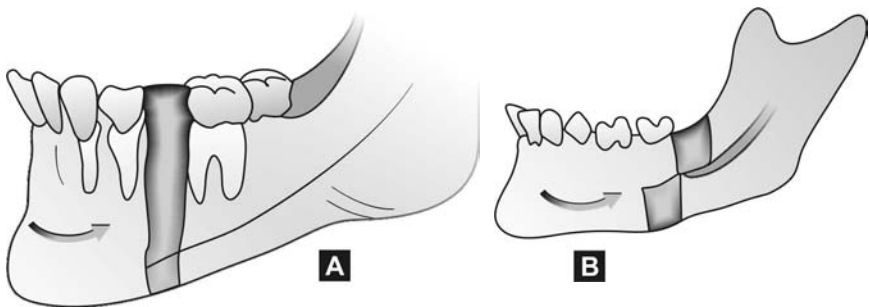
Jaw bones are intentionally sectioned at various sites to correct the dentofacial deformities and then repositioned at the desired position. One of the following bony surgical procedures could be chosen for the correction of an individual dentofacial deformity.

- i. *Mandibular body osteotomies*
 - a. Anterior body, posterior body or mid-symphysis osteotomy with an intra-oral approach.
 - b. Segmental subapical mandibular surgery.
 - c. Genioplasty—horizontal osteotomy in the chin region.
- ii. *Mandibular ramus osteotomies*
 - a. Extra-oral or intra-oral sub-condylar ramus osteotomy.
 - b. Intraoral modified sagittal split osteotomy.
- iii. *Maxillary osteotomy procedures—Intra-oral procedures*
 - a. Segmental anterior maxillary or posterior maxillary osteotomy.
 - b. Total maxillary surgery—LeForte I osteotomy
 - Advancement of maxilla
 - Superior or inferior repositioning of maxilla.

Mandibular Body Osteotomy

Anterior Body, Posterior Body Mid-symphysis Osteotomy

- a. *Anterior body osteotomy:*
Indication: Skeletal CI-III malocclusion with mandibular prognathism and with or without anterior open bite.
Procedure: Removal of 1st or 2nd premolars would be required. Vertical osteotomy cuts are placed in the extraction sockets at the alveolar margin going towards the inferior border on both sides of the mandible. Osteotomized segment is set back and fixation with intra-osseous wiring is provided (Fig. 7.4A).
- b. *Posterior body osteotomy:*
Indication: Some cases of skeletal CI-III malocclusion with presence of cross bite.
Procedure: Vertical osteotomy cuts are started at the site of posterior teeth, one tooth anterior and one tooth posterior to the osteotomy site, extending up to external oblique ridge. Fragments are approximated in such a way that neurovascular bundles are not damaged and fixed with intra-osseous wiring (Fig. 7.4B).



Figs 7.4A and B: A. Anterior body osteotomy and setback of the osteotomized segment;
B. Posterior body osteotomy and setback of the osteotomized segment

c. *Mid-symphysis osteotomy:*

Indication: Skeletal CI-III with prognathic mandible and anterior cross bite.

Procedure: Osteotomy cuts are made in the anterior symphysis area between two mandibular incisors from the alveolar crest to the inferior border and the anterior segment is set back and fixed.

Segmental Subapical Mandibular Surgeries

Indication: For repositioning anterior, posterior or entire mandibular dentoalveolar segment.

Anterior Subapical Mandibular Osteotomy

Indication: For correcting mandibular dentoalveolar prognathism, closing anterior open bite by leveling the curve of spee.

Posterior Subapical Mandibular Osteotomy

Indication: For up-righting and leveling posterior segment—For closing posterior spaces.

Genioplasty

Genioplasty is, basically, a horizontal osteotomy in the symphysis region done to augment, reduce, straighten or lengthen the chin.

Augmentation Genioplasty

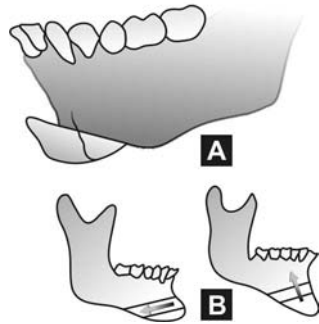
Indication: Skeletal CI-II malocclusion with retrognathic and under-developed chin.

Procedure: This is done to increase the chin prominence. A horizontal sliding osteotomy of the symphysis is done, the cut being made 4 mm below the apices of the canines. The segment is mobilized and advanced in the desired position. Autogenous or alloplastic bone grafting is done at the site for better fixation to the superior body (Fig. 7.5A).

Reduction Genioplasty

Indication: Skeletal CI-III malocclusion with a prognathic chin and a long face.

Procedure: Reduction of symphysis can be done in horizontal as well as vertical plane depending upon the need of the case (Fig. 7.5B). Horizontal osteotomy can be placed and the fragment can be set back. Vertical reduction of the fragment with a posterior pushback may be done in some cases.



Figs 7.5A and B: Augmentation genioplasty; **B.** Sliding reduction genioplasty

Straightening Genioplasty

Indication: Patients with facial asymmetry.

Procedure: Horizontal osteotomy cut is placed and the segment is shifted laterally to get the desired facial symmetry.

Lengthening Genioplasty

Indication: Skeletal CI-II cases with deep bite.

Procedure: This is performed in patients with short vertical facial height where the osteomized segment is depressed and the bone graft is placed in this area to lengthen the face.

Mandibular Ramus Osteotomies

Vertical Ramus Osteotomy

Indication: Can be performed to correct mandibular excess as well as deficiency.

Procedure: The ramus is vertically sectioned from the sigmoid notch to the lower border of the mandible through a submandibular approach. For mandibular excess, osteotomized segment is removed and for mandibular deficiency, a bone graft is placed at the osteotomy site (Fig. 7.6).

Intra-oral Modified Sagittal Split Osteotomy

This is also called *bilateral sagittal split osteotomy* (BSSO). Here, the osteotomy splits the ramus and the posterior body of the mandible sagittally, which allows either set back or advancement of the mandible (Fig. 7.7).

Maxillary Osteotomy Procedures

Segmental Anterior Maxillary Osteotomy

Indication: To correct dentoalveolar prognathism of anterior maxilla.

Procedure: The anterior segment of the maxilla can be osteomized and moved either superiorly, inferiorly, or posteriorly as per the need of the case (Figs 7.8A and B).

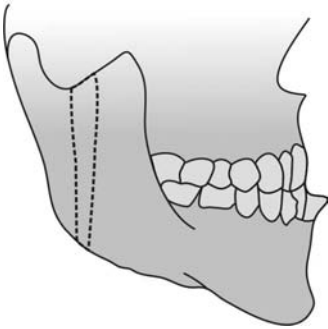


Fig. 7.6: Sub-condylar mandibular ramus vertical osteotomy

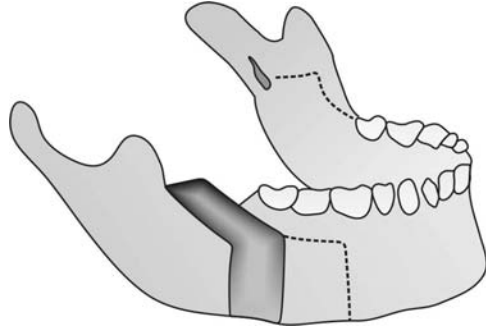
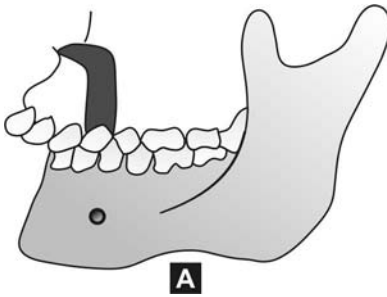
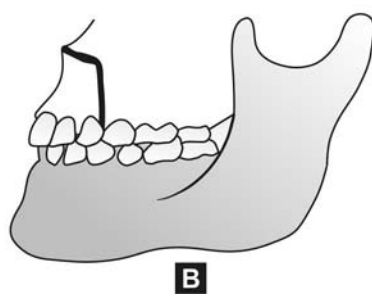


Fig. 7.7: Bilateral intra-oral sagittal split osteotomy of ramus



A



B

Figs 7.8A and B: **A.** Maxillary anterior osteotomy for correction of prognathic maxilla;
B. Setback of maxilla

Segmental Posterior Maxillary Osteotomy

This is done to reposition a posterior supra-erupted segment to close the posterior open bite and also, correct cross bites. A horizontal osteotomy cut is made from canine to the first molar region.

Total Maxillary Surgery-LeForte I Osteotomy

This is indicated when deformities of maxilla exist in more than one plane. Multiple segmentalization of the maxilla can be done to reposition the entire dentoalveolar segment of maxilla superiorly, inferiorly, anteriorly, and posteriorly or to widen or level the maxilla.

Certain cosmetic surgeries like 'lip switch' surgery or 'rhinoplasty' provide a means of improving the patient's soft tissue profile. Lip switch surgery is done for patients having a cleft lip, which repairs the lip and improves the patient's soft tissue profile and eliminates the excess pressure from the repaired tight upper lip.

Orthodontists can suggest to the parents 'rhinoplasty' for their child in cases where a carefully re-contoured nose would compliment orthodontic results. A change in the contour of the nose can, sometimes, cause to seem as if patient's teeth and lips have moved forward or as if the patient has

experienced mandibular growth. Thus, rhinoplasty is gaining importance among the orthodontists as they are realizing that nasal growth is more often related to an unpleasing face than excessive or lack of mandibular growth.

POST-SURGICAL PHASE

After the selected surgery is performed, a 4-6 week period of rest, healing and consolidation is allowed under the surgeon's observation. After this, the following orthodontic steps have to be taken:

- i. The inter-occlusal splint and the heavy stabilizing arch wires are removed.
- ii. Light arch wires are placed to allow setting of occlusion.
- iii. Light inter-dental elastics can be used for correct inter-digitation.

Objectives of this phase are:

- i. To make finer alignment of teeth with maximum inter-digitation and closure of remaining spaces.
- ii. To provide retention and re-adaptation of the musculature to prevent relapse.

8

Management of Class I (CI-I) Malocclusion

CI-I MO is a malocclusion in which the molars are in normal Class I relationship but the teeth anterior to the molars are mal-aligned. The normal molar Class I relationship means that the mesiobuccal cusp of the upper 1st molar occludes with the mesial surface of the mesiobuccal groove of the lower 1st molar. The lower dental arch is in normal relation to the upper dental arch as indicated by the molar relationship (of 1st permanent molars). The inter-arch relationship is normal, but the malocclusion is restricted to irregularities of individual teeth.

Class I malocclusion might be present with a combination of two or more of the following intra-oral irregularities:

- Proclination
- Midline diastema
- Rotations of teeth
- Posterior cross bite
- Deep bite
- Spacing of teeth
- Crowding of teeth
- Anterior cross bite
- Anterior open bite
- Retroclination of anterior teeth.

Patients with Class I malocclusion need correction of any of these features present. The treatment is undertaken mainly in adolescent age group and sometimes also in adults. The primary concern of the patients for seeking treatment in these cases is mainly the aesthetic correction. But in certain cases, treatment can also be started in the mixed dentition phase.

In the mixed dentition phase, a need for the maintenance of arch length might be required when a primary canine or a molar is lost prematurely or there is presence of crowding in the lower arch. Lower lingual holding arches, fixed or combination of fixed and removable, are used to maintain arch width and arch length (Fig. 8.1).

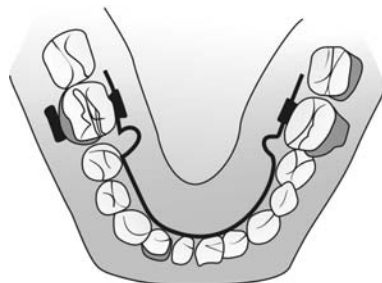


Fig. 8.1: Lower lingual holding arch

The Nance palatal holding arch can be used to maintain the maxillary arch length. Fixed or removable transpalatal arches are used to maintain, expand or constrict the inter-molar width, to rotate, upright mesially tipped molars and to torque the maxillary molars.

When the mixed dentition analysis predicts that there is presence of mild crowding in the lower arch, the arch length is regained and the incisors

are aligned or the space is maintained after regaining arch length. Also, developing anterior cross bites can be treated in the mixed dentition phase.

As aesthetics is the primary concern, the treatment is usually undertaken in full permanent dentition. A choice between removable and fixed comprehensive appliances should be made upon the type of tooth movement required, patient's compliance and affordability.

Removable appliances use Adam's clasps to clasp the anchor teeth, finger springs embedded in the acrylic body, labial bows and jackscrews in special expansion plates. The major advantage of the removable appliance is that patient is able to remove the appliance during treatment and can keep his teeth and gums clean. But, the patient has to be cooperative enough to wear the appliance as per instruction of the dentist. Tooth movement achieved is primarily 'tipping'; so it may not be advisable in cases of generalised spacing, crowding and rotations.

FIXED APPLIANCES

Best results are achieved with complete fixed appliances with or without extractions, to gain space to correct crowding of teeth and protrusion of dental arches. Any appliance system such as Begg light wire system or any form of standard or pre-adjusted Edgewise appliance or any combination technique can be chosen as per the skill of the clinicians, patient's expectations and desired tooth movements. The Begg system works on 'double tipping principle' that is crown tipping followed by root up-righting. This is good in both extraction and non-extraction cases, especially because no special anchorage appliances are required.

The Edgewise appliances, especially the pre-adjusted Edgewise appliance, can move tooth bodily and torque the teeth in the buccolingual plane around an arch. So, if precisely placed, the PEA system can produce the finest and most stable finished occlusion.

As mentioned earlier, Class I malocclusion cases need correction by alignment of crowded or spaced teeth, leveling of the overbite (deep bite or open bite), rotation corrections, overjet correction by treating protrusion or retroclination of teeth, arch expansions and correction of cross bites. The general steps of fixed appliance therapy (any of the above) in the treatment of Class I malocclusion are discussed below:

- *Initial alignment* is usually achieved by light round wires, common choice being Nickel Titanium wires and braided steel wires with diameters ranging from 0.012 to 0.018. Begg appliance also encourages the use of initial multi-looped wires for initial arch expansion and alignment and then, these multi-looped wires should be replaced by plain arch wires. Towards the end of alignment phase, brackets become well aligned on the arch wire. Bracket repositioning can be done at this point rather than placing bends in the arch wire and the same light arch wire could be continued for further alignment.
- *Leveling of teeth (correction of deep bite)* is achieved through intrusion of anterior teeth, extrusion of posterior teeth or a combination of both.

Facial height is the last growth to be completed and orthodontists bank on this growth to enhance the treatment mechanics. Differential tooth movement between anterior and posterior teeth allows the correction of deep bite.

Incisor intrusion is indicated in patients with more maxillary incisor display at rest or when smiling. Bypass arches that bypass the premolars and have activation points at the molar tube area are used for this purpose. Prefabricated or individualized intrusion arches or utility arches are used for incisor intrusion.

Posterior extrusion is indicated in growing patients with a flat mandibular plane. Individualised extrusion arch wires with CI-II inter-maxillary elastics and anterior bite plates allow posterior extrusion with CI-II inter-maxillary elastics.

Combined anterior intrusion and posterior extrusion can be achieved by using reverse curve arch wires. For details, one should refer chapter No. 12 on correction of deep bite.

- *Maintenance of Class I molar relationship* is the main objective while aligning and leveling the teeth mesial to the molars. So, anchorage control is desired. This involves the ability to achieve differential mesial distal tooth movement of anterior and posterior teeth. Extra-oral appliances may be used in the case of Edgewise appliances while in the Begg appliance system, the forces are so light that no extra-oral appliances are required to augment the anchorage. The correct placement and the proper amount of anchor bends along with inter-maxillary elastics is the key factor in avoiding adverse molar movements in the Begg appliance. Proper cementation of bands and proper use of elastic force also should be confirmed. The inter-maxillary elastics (CI-II elastics) are means of gaining differential tooth movement.

Nance palatal holding arches and lip bumpers can be used to augment intra-arch anchorage by resisting mesial migration of molars during anterior retraction, especially in the premolar extraction cases. Separate canine retraction followed by incisor retraction can be done to preserve posterior anchorage in the Edgewise system.

In the Begg system, en-masse mesial movement of upper and lower 12 anterior teeth can be done by carefully observing the treatment mechanics. Closure of extraction spaces should be followed by root alignment of adjacent teeth.

- *Correction of axial inclinations of teeth:* This includes root paralleling and establishing correct inclination of teeth within their basal bone (Fig. 8.2). In the Begg technique, the crowns tip towards each other and root apices are away. So, up-righting springs are used to upright the canines and premolar roots across the extraction site. Retraction of incisors may tip them lingually and hence, lingual movement of incisor roots is required to obtain correct axial inclination. This is termed as torque. In Begg technique, this is achieved by torquing auxiliaries used in the stage III of treatment.

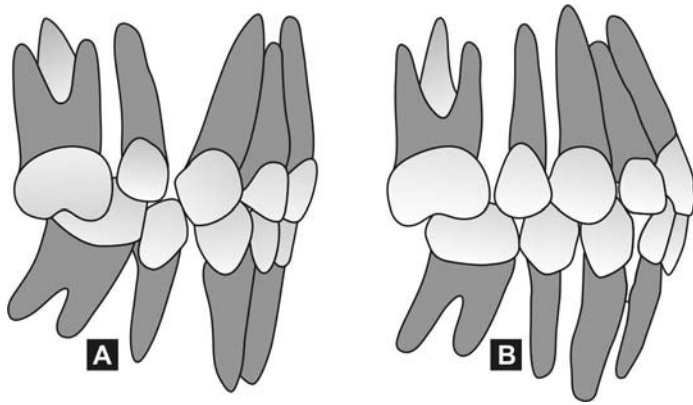


Fig. 8.2: A. Axial inclinations of teeth (extraction case) after space closure;
B. Correction of root positions and axial inclinations

In the Edgewise system, bends are incorporated in the wire system to achieve these effects. In the pre-adjusted Edgewise system, the brackets are pre-engineered to automate these tooth movements when rectangular wires are engaged into them.

- *Finishing and occlusal refining* might be needed towards the end of the treatment. For the Begg system, 0.016 inch Australian or stainless steel arch wires can be formed with precise bends in it for occlusal detailing. For the Edgewise systems, ideal bracket positioning is the first requirement. Flexible rectangular beta titanium wires can be used for finishing and detailing. In all the appliance systems, vertical or interlacing elastics between upper and lower posterior teeth can be used for correct inter-digitation of occlusion.
- *Retention* of the result achieved is a must after appliance removal. Removable or a bonded retainer can be chosen as per the need of the case.

Let us discuss the individualised problems in Class I malocclusion.

PROTRUSION

Most common condition is a bi-maxillary protrusion, which is mainly dentoalveolar bi-maxillary protrusion. Skeletal bi-maxillary protrusion is usually not very frequently prevalent.

Bi-maxillary Dentoalveolar Protrusion

- Spacing between teeth is usually present.
- Both the arches show proclined teeth.
- Molar canine relationships are normal.
- Soft tissue profile is slightly convex or more convex depending on the severity of protrusion.
- Lips are usually everted and competency of lips depends on the extent of protrusion.

- In some cases, instead of spacing, bi-maxillary protrusion could be present with mild crowding and rotations of teeth. This is a characteristic feature of the Keralites.

Bi-maxillary Skeletal Class I Protrusion

- There is a true prognathism of both the jaws i.e. both maxilla and mandible have a relationship more forward than normal with respect to the cranial base. This is characteristic of Negroid race.
- Profiles are convex in appearance.
- Molar relationships are normal.
- The axial inclination of teeth is near normal.

Treatment

If enough spacing is present, then extraction of teeth is not required for retraction of upper and lower teeth. If enough spacing is not present, then all four 1st premolars are extracted followed by fixed appliance therapy. For true skeletal protrusion, surgical correction is advised. Usually, sub-apical osteotomy with concomitant extractions of 1st premolar is the preferred procedure for surgical correction.

SPACING

Spacing is a commonly seen feature in Class I malocclusion. It may be generalized in the entire dentition or may be localised between certain teeth. Spacing is usually present due to one of the following reasons, which should be evaluated during treatment:

- Disproportion between arch length and tooth material, e.g. conditions such as oligodontia or microdontia leading to spacing.
- Small size peg lateral.
- Oral habits such as thumb sucking or tongue thrusting.
- Abnormally large tongue.
- Erupted or un-erupted supernumerary teeth.
- Localized causes leading to midline diastema (Refer to chapter on 'Midline Diastema').

If spacing is associated with proclination of teeth, choice of appliance can be done between removable or fixed appliances depending on the expectation and affordability of the patient. But a comprehensive appliance therapy with fixed appliances, preferably PEA system, would give an ideal results.

Retraction components for removable appliances are labial bow, elastics and finger springs. Uniformly space closing components for fixed appliances are elastomeric power chains, elastic thread, elastics, and closed coil springs.

If the spacing is due to relative tooth size-jaw size discrepancy, then space redistribution with fixed appliances followed by aesthetic enlargement of teeth (composite or porcelain veneers or crowns) is the correct line of treatment to close the space.

CROWDING

Model analysis should be done to identify the amount of space discrepancy to decide the line of treatment. But first, it is essential to evaluate the underlying cause of crowding to decide the correct line of treatment. It could be:

- Presence of large size teeth leading to space discrepancy.
- Inherent arch length and tooth substance discrepancy.
- Presence of over-retained deciduous teeth along with their succedaneous erupted permanent teeth.
- Presence of supernumerary teeth.
- Premature loss of deciduous teeth.

The line of treatment is to gain the required space for alignment of teeth and then follow a comprehensive appliance therapy. Removable appliances are not ideal for completely treating Class I malocclusion with crowding. Space can be created by various orthodontic means mentioned below:

- Proximal stripping.
- Arch expansion.
- De-rotation of adjacent posterior teeth
- Proclining anterior teeth
- Extraction of 1st or 2nd premolars to create space for alignment of rest of the teeth.

Proximal Stripping

Indicated when space discrepancy is minimal (2.5-3.0 mm per arch) and there is very mild crowding. It is chosen to treat localized mal-alignments especially in adults with borderline discrepancy so as to avoid extractions. Proximal stripping actually means disking or selective reduction of the mesiodistal width of certain teeth to create space for alignment of teeth. Most commonly selected teeth for proximal slicing are mandibular incisors and canines and premolars of both the arches. Teeth selected for proximal disking should have sound enamel and no caries. Procedure is contraindicated for teeth with caries susceptibility and large pulp chambers.

Procedure

Space analysis should be done, preferably by using Carey's model analysis. Then, intra-oral periapical X-rays should be taken of the tentatively selected teeth to assess thickness of the enamel. Then stripping should be done in such a way that the space created is distributed over large number of teeth between mesial and distal surfaces to reduce amount of enamel loss over one particular area. It is, best, done by using *metal abrasive strips* or thin fissure burs. Abrasive particles are attached to metal abrasive strips, usually on one side to make them safe towards adjacent teeth. Fine, safe-sided metal abrasive strips should be used to avoid enamel scratching and unwanted stripping. Carborundum disks are not much used now because

of their brittleness and breakage during use. Thin straight fissure or tapered fissure burs can also be used carefully for enamel reduction. But, this usually leaves deep scars on the reduced enamel; hence, it should be followed up with metal abrasive strips and polishing.

Proximal slicing should be done in such a way that there should be no sensitivity, caries susceptibility or bad teeth contacts following the procedures.

Arch Expansion

This means an increase in the circumference of dental arches to gain space to align crowded teeth or correct cross bites. Model analysis should be done to analyse space discrepancy. If the space discrepancy is less than 4 mm and can be corrected by expansion, slow expansion with a removable screw plate, quad helix or fixed appliance should be carried out. Rapid maxillary expansion should be performed in case the space discrepancy is around 4-12 mm and the arch is narrow and needs to be expanded. Adult patients of this category would require surgically assisted rapid palatal expansion. Arch expansion has already been discussed in parts in various different chapters; that is why only brief description is being given here.

As discussed above, the expansion performed could be slow or rapid depending on the space discrepancy.

Slow expansion is a dentoalveolar expansion. The force generated to produce this type of expansion is 2-4 pounds. The amount of expansion achieved is 0.5-1 mm per week. Expansion is carried out in 3 months and retention in 3-4 months. Appliances used to achieve this type of expansion are:

- Split removable acrylic plate with midline jackscrew.
- Coffin spring.
- Quad helix.
- Fixed appliances with expanded arch wires.

Rapid expansion is a skeletal expansion. Force generated to produce this type of expansion is 10-20 pounds. Rate of expansion is 0.2-5.0 mm per day. 1-2 rotations per day should be prescribed. Usually, the fixed hyrax appliance is used to achieve palatal expansion, which takes about 2 weeks to complete and stabilization and retention phase extends to 3-6 months.

De-rotation of Posterior Teeth

Posterior teeth occupy more space when they are rotated or tipped. Thus, space is gained by de-rotating and aligning posterior teeth, which can be used for alignment of anterior teeth. This is accomplished by using fixed appliances. Offsets are placed in the arch wire in the related tooth area. In the PEA system, precise bracket positioning, use of light aligning wires and final engagement of rectangular wires in brackets de-rotates the rotated teeth.

- *Proclining anterior teeth* increases the arch circumference to align the teeth. This is usually done when anteriors are retroclined and crowded.

Fixed and removable appliances are used for this purpose.

- *Extraction of 1st and 2nd premolars to create space for alignment of rest of the teeth:* Carey's arch perimeter analysis is an important factor in deciding whether to extract teeth or not.
 - If the space shortage is 0-2.5 mm, then no extractions are needed. Space is gained by proximal stripping or expansion of arches.
 - If the space shortage is between 2.5-5 mm, then it is a borderline extraction case and would require extraction of second premolars where the space is closed by retracting anterior teeth and mesializing the molars.
 - If the space shortage is more than 5 mm, extraction of 1st premolars is required as most of the space is utilized in aligning crowded teeth and then retracting the anterior aligned segment.

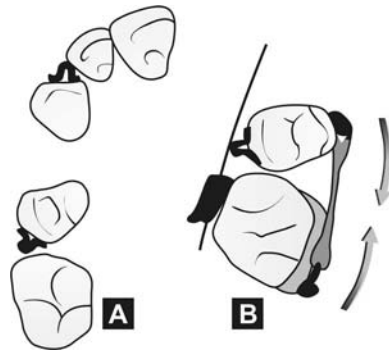
Comprehensive fixed appliance therapy should be done following extractions of premolars.

ROTATION CORRECTION

Tooth movements occurring around their long axis are called rotations. When the anterior teeth are rotated, they occupy less space and therefore, additional space would be required for de-rotation. Fixed appliances are best for correction of rotations as they have a three-dimensional tooth control. The additional space is gained by expansion arch wires or open (push) coil springs and then, the anterior teeth are de-rotated.

Offsets are bent in the wire or the brackets are off-setted and ligated with elastic thread or ligature wire to the arch wire for rotation correction. Also, de-rotation springs can be used in the vertical slot brackets (Fig. 8.3). But in the PEA system, the precise positioning of the pre-engineered brackets, initial alignment in light round wires followed by perfectly fitting rectangular wires, corrects the individual rotations. Posterior teeth occupy more space when they are rotated. Thus, space is gained when posterior teeth are de-rotated. The rotations must be over-corrected and supra-crestal fibrotomy should be done to retain de-rotated teeth in stable positions.

Cross bite correction, deep bite correction, and open bite correction have been discussed in separate chapters in this book. One may refer to them for the sake of completeness.



Figs 8.3A and B: A. Brackets are off-setted to de-rotate canine and premolar; B. Elastic thread tied to the lingual attachments to de-rotate premolar and molar

9

Management of Class II (CI-II) Malocclusion

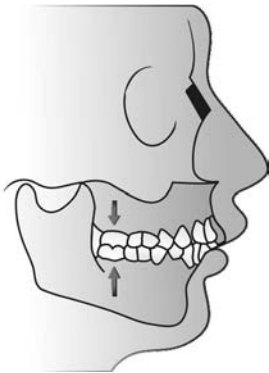


Fig. 9.1: Distal antero-posterior relation of mandibular first molar in relation to maxillary first molars in Class II malocclusion. Note the increased over jet

Class II malocclusion is described by Angle as the condition in which mandibular first molars occlude distal to the normal relationship with the maxillary first molars (Fig. 9.1). Further, CI-II malocclusion was differentiated into Class II, div I in which maxillary incisors are protruding and Class II, div II in which maxillary incisors are retruding. But Class II malocclusions are mainly differentiated on the basis of underlying dental or skeletal deformity.

DENTAL CLASS II MALOCCLUSIONS

The skeletal jaw relationship is normal with dental class II malocclusion, where the maxillary molars have moved forward more than normal during the development period, but mandibular molars have remained in relatively more posterior position. Thus, the dental causes of this malocclusion are mainly maxillary dental protrusion and mesial drift of maxillary first permanent molars. When maxillary dental protrusion is the underlying dental cause, it can be differentiated from skeletal maxillary protrusion as there is dentoalveolar protrusion only of the maxillary anterior arch affecting only the lips and not the entire midface. The mandibular dentition is usually in normal anteroposterior position, but there could be excessive overjet due to protruded and spaced maxillary incisors. Oral habits are one of the important reasons for this manifestation.

When mesial drift of the maxillary first permanent molars due to loss of mesial proximal contact is the underlying dental cause, then maxillary first permanent molar assumes a more mesial position resulting in Class II permanent molar relationship. Here, there is a normal overjet with crowding of maxillary arch caused by space loss in the arch length.

Sometimes, congenital absence of maxillary second premolars or very small sized second premolars would cause mesial drift of the maxillary permanent first molars into a Class II relationship, with or without maxillary anterior spacing. In other cases, displacement or impaction (due to lack of space) of maxillary canines and second premolars may result in mesial

drift of maxillary first molars into a CI-II relationship with anterior crowding.

SKELETAL CLASS II MALOCCLUSION

This malocclusion results from an antero-posterior disproportion in size or discrepancy in the position of jaws rather than malposition of teeth relative to the jaws. Skeletal CI-II malocclusions can be sub-divided into:

- i. Skeletal CI-II malocclusion comprised of mandibular deficiency.
- ii. Skeletal CI-II malocclusion comprised of maxillary excess.
- iii. Skeletal CI-II malocclusion comprising of combination of mandibular deficiency and maxillary excess.

Skeletal CI-II Malocclusion with Mandibular Deficiency



Fig. 9.2A: Mandibular deficiency due to small mandibular ramus and small mandibular body. Note the eversion of lower lip lying lingual to maxillary incisors

Here, the mandible is small and retruded relative to the maxilla. There is relative protrusion of maxillary anterior teeth and relative deficiency of the chin caused by underdeveloped or retruded mandible. When the mandibular deficiency is great, the lower lip would be positioned lingual to the maxillary incisor at rest and there would be further protrusion of maxillary incisors as a consequence. Also, there is over-eruption of maxillary incisors. These are the features that correspond to Angle's Class II, div I malocclusion (Fig. 9.2A).

There is one more type of mandibular deficiency where there is decreased size of mandibular body and mandibular

rami is of normal length (Fig. 9.2B). These cases represent short lower anterior face height and normal posterior face height. There is often associated deep bite with lingually inclined maxillary incisors. This decreased overjet further masks the antero-posterior dental discrepancy. Also, both upper and lower lips have more everted position at rest. These features correspond to Angle's Class II, div 2 malocclusion.

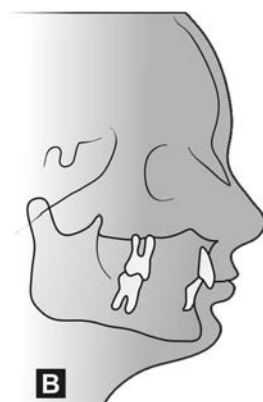


Fig. 9.2B: Mandibular deficiency due to small mandibular body with a normal size ramus

Skeletal Class II Malocclusion with Maxillary Excess

There is an over-development of the maxilla in vertical or antero-posterior dimension. When the vertical maxillary excess is more localized to the

posterior area, the maxillary posterior teeth have taken a more inferior position, but the incisors are in a normal vertical position leading to an anterior open bite.

When there is an overall vertical maxillary excess, both anterior and posterior maxillary teeth are located inferiorly with no open bite but with excessive vertical display of maxillary incisors and gingiva upon smiling. In both the conditions, there is maxillary vertical excess and the mandible has a clockwise i.e. downward and backward rotation leading to skeletal Class II relationship. There is, usually, an increased lower anterior face height with relative chin retrusion and maxillary incisor protrusion. Lip incompetence, also, is a common feature seen with maxillary excess. These features correspond to Class II, div 1 malocclusion.

Skeletal CI-II Malocclusion with a Combination of Mandibular Deficiency and Maxillary Excess

Here, both mandibular deficiency and maxillary excess add to the severity of the antero-posterior skeletal problem (Fig. 9.3). This basic knowledge is absolutely essential to plan out the treatment of dental and skeletal Class II malocclusion. Whether dental or skeletal Class II malocclusion, the treatment objectives of Class II, div 1 and Class II, div 2 should be clear.

Treatment objectives of Class II, Div 1

- i. Improving esthetics
- ii. Correction of increased overjet
- iii. Correction of deep bite
- iv. Repositioning of crowded anterior teeth
- v. Correction of Class II molar relationship
- vi. Leveling the curve of spee.

Treatment Objectives of Class II, Div 2

- a. Correction of incisal relationship.

Three types of incisal relationship could exist:

- i. Central incisors are retroclined and lateral incisors are proclined.
- ii. Central and lateral incisors are retroclined and canines are labially placed.
- iii. All interiors are retroclined.
- b. Correction of deep bite.
- c. Correction of inclinations of anterior teeth and elimination of gingival trauma.
- d. Correction of molar relationship.
- e. Leveling of curve of spee.

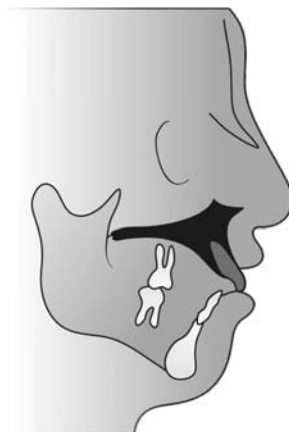


Fig. 9.3: Combination of mandibular deficiency with vertical maxillary excess

MANAGEMENT OF DENTAL AND DENTOALVEOLAR CL-II MALOCCLUSION

Most of the Class II malocclusions are present with some degree of underlying skeletal discrepancy. But in some Class II conditions, the skeletal jaw relation is absolutely normal but, there is a Class II dental relationship. These are mainly caused by the mesial movement of maxillary molars during their development with or without the presence of deleterious oral habits. The line of treatment of such dental malocclusions include

- i. Elimination of oral habits during mixed dentition period (discussed in earlier chapters).
- ii. Distal movement of maxillary molars and then retracting anterior maxillary teeth (non-extraction approach).
- iii. Non-extraction approach when there is adequate spacing along with proclination of maxillary anterior teeth. This is done with complete fixed or removable appliances.
- iv. Carrying out extractions to obtain space for retraction of anterior maxillary teeth.

Distal Movement of Maxillary Molars

Successful distal movement of molars depends on the severity of mesial drift of maxillary permanent molars. In the case of tipped molar crowns, intra-oral spring force applied to removable or fixed appliance can be used to retract other maxillary teeth. If the permanent maxillary first molar has drifted bodily due to premature loss of primary second molar, then the molars assume a Class II relationship and the loss of arch length produces anterior crowding. This requires bodily distal movement of maxillary molars to correct the molar relationship and create space for alignment and retraction of anterior teeth.

The best time to distalize first permanent maxillary molars is 10-11 years of age. This is, usually, achieved by a full time headgear wear with 1 lb pressure on each side. Use of transpalatal bar soldered to the lingual sheath of both the 1st molar bands keeps the molars upright and maintains the inter-molar width. Molar distalization has also been discussed in the later part of this chapter.

Extractions to Obtain Space for Alignment of Maxillary Teeth

This is carried out when permanent teeth have fully erupted in the mouth. When the maxillary molars have drifted bodily into a Class II relationship and there is crowding in the anterior segment due to loss of arch space, then another more practical approach is to accept the molar relationship and create space for alignment of anterior teeth by extracting maxillary 1st or 2nd premolars. If the lower arch is well aligned, extractions can be avoided in the lower arch. If there is discrepancy in both the arches and inadequate overjet is present, then the mandibular extraction may be necessary along with maxillary extractions.

The case should be treated with complete fixed orthodontic appliances with light wire technique or by the Edgewise system.

MANAGEMENT OF SKELETAL CLASS II MALOCCLUSION

There are three alternatives for treating skeletal problems depending on the age of the patient and severity of the malocclusion:

- a. Growth modification
- b. Dental camouflage
- c. Orthognathic surgery

Growth Modification

The aim is to alter the skeletal relationship by modifying the patient's remaining facial growth to favorably change the dimension and position of jaws. This is usually done during the 'mixed dentition' period when favorable facial growth is remaining.

Growth modification of skeletal Class II problems is done by three types of appliances:

- i. Extra-oral headgear appliances
- ii. Functional appliances
- iii. Inter-arch traction

Extra-oral Headgear Appliances

This is designed to deliver an adequate extra-oral orthopedic force to compress the maxillary sutures and modify the pattern of bone apposition at these sites. The ideal indication for use of headgear appliance in correction of skeletal CI-II malocclusion is skeletal CI-II malocclusion with antero-posterior maxillary excess, with or without mandibular deficiency. The headgear would restrict the anterior and inferior maxillary growth and allow the mandible to grow forward to catch up with the maxilla. The headgear delivers a posteriorly directed extra-oral force to the maxilla.

Headgear consists of a metal device attached extra-orally to an occipital or cervical attachment and intra-orally to appliance fixed to the teeth. The force is transmitted to the dental arches by:

- i. Extra-oral arch, which fits into the molar tubes. It is made up of two elements:
 - a. Inner labial arch, which engages in tubes.
 - b. Outer arch, which hooks onto the neck strap or head cap.
- ii. 2 'J' hooks, which engage to the anterior part of the arch wire.

Magnitude of Force

To produce orthopedic changes in the position of maxilla, larger forces are required. Graber suggests that 1-2 lb of force on each side of cervical traction retards maxillary growth. These large forces are distributed widely and evenly to all the teeth of the maxillary arch and these forces surpass the tooth-moving threshold, bringing about orthopedic changes.

Duration of Force

This force should be, preferably, continuous but 12-14 hours of duration is a must.

Age of the Patient

The skeletal system of the younger patient is more dynamic possessing a greater capacity to remodel. Hence, mixed dentition period is the ideal time for this appliance therapy. Advantages of early headgear therapy for correction of skeletal Class II are:

- i. Reduces skeletal discrepancy by holding back maxillary development in CI-II cases and allows the mandibular growth to catch up.
- ii. Provides opportunity for normal development of musculature.
- iii. Reduces danger of fracture of protruding incisors and discourages sucking habits.

Intra-oral Preparation for Headgears

When the headgear is attached intra-orally to the maxillary first permanent molars, the only preparation is fitting and cementing bands with headgear tubes on these molars. Sometimes, a short period of orthodontic treatment with active transpalatal arch would be required to de-rotate the mesiolingually rotated maxillary first molars to permit face bow insertion. When the headgear is attached intra-orally to removable or functional appliance, the headgear tubes are incorporated into the acrylic occlusal to the maxillary premolars.

Delivery of J-hook requires bonding of maxillary incisors and banding of maxillary molars and stiff arch wires (0.017 x 0.025 stainless steel) to support orthopedic forces. This might require initial period of alignment before placement of stiffer wires.

Delivery of Headgear

Final adjustments are made for the inner bow, the outer bow and selection of occipital or cervical attachment is done to dictate the final force correction. Then, the dentist should demonstrate to the patient and his/her parents how to safely connect and disconnect the headgear attachment to the face bow instructing the avoidance of wear during sports and other physical activity. The child should, then, practice placement and removal of the appliance. There would be extreme discomfort to the child if he wears the appliance with large orthopedic forces for greater duration. So to prevent this, initial duration or magnitude of the force can be reduced and gradually increased within first 2 weeks.

Follow-up Appointments

First follow up visit: 2 weeks after delivery of headgear to assure good patient management with the appliance and to eliminate the difficulties of the patient in planned use of the appliance.

Second follow up visit: 1 month after the 1st follow up visit to confirm and monitor the patient compliance.

Frequent visits, each at the interval of 1 month: Look for the antero-posterior improvement in occlusion and for decreased overjet as desirable indications. Adjust the inner bow at each appointment to achieve the desired de-rotation and expansion of maxillary molars. Adjust the force magnitude and appropriate force direction. Over-correction of the malocclusion and continuance of orthopedic treatment until maxillary growth completion are recommended to prevent relapse and re-expression of the patient's fundamental growth pattern.

Functional Appliances

Functional appliances for correction of skeletal Class II are designed to enhance the downward and forward growth of the mandible by altering the muscle tension on the condyles and increasing the amount of bone growth. Dentally, the appliance would inhibit the mesial and occlusal eruption of maxillary posterior teeth and encourage mesial eruption of mandibular posterior teeth.

Ideal indications for functional appliance therapy in treatment of skeletal Class II malocclusion are:

- i. Skeletal Class II malocclusion with a mandibular deficiency.
- ii. Skeletal Class II malocclusion with decreased face height.
- iii. Skeletal Class II malocclusion with slightly protrusive maxillary incisors and slightly retrusive mandibular incisors as the appliance can bring about maxillary incisor retraction and mandibular incisor protraction.

These patients must have an active mandibular growth.

Various functional appliances that can be used for correction of Class II skeletal malocclusion

Removable Tooth-borne Appliances

- Activator
- Bionator
- Twin block

These appliances depend on the soft tissue stretch caused by forward and downward positioning of mandible and the muscle tension generated by the mandible in attempt to return to its previous position (Fig. 9.4).



Fig. 9.4: Diagrammatic representation of the occlusal view of a typical Class II bionator

Removable Tissue-borne Appliance

Functional regulator: This appliance re-contours the facial soft tissue adjacent to the teeth by influencing arch expansion and posturing the mandible

downward and forward. It seems to work better as a daytime appliance because of the improved ability to speak with the appliance in the mouth and provides transverse expansion from the buccal shields (Fig. 9.5).

Fixed Tooth-borne Appliance

Herbst Appliance

This maintains the mandible in forward position and has the advantage of fulltime wear. The mandible is maintained in a forward position by a telescopic rod and a tube device that is attached bilaterally from the maxillary first molars to the mandibular first premolars.

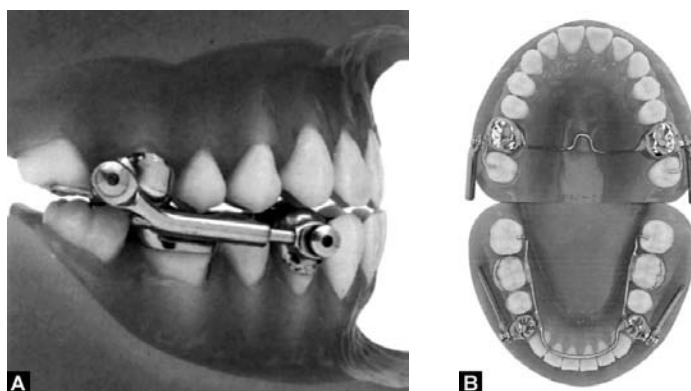
Appliance modification: The rigid telescopic mechanism is replaced with a flexible plastic covered open coil spring attached to the auxiliary wires with a complete or partial fixed appliance (Figs. 9.6A and B).

Intra-oral Preparation for Functional Appliances

Growth modification can take place only if the myofunctional therapy is started in adolescence in the mixed dentition period to take advantage of the active mandibular growth. Sufficient overjet should be present for forward positioning of the mandible. In the cases of Class II div 2 malocclusion, cases with proclined mandibular incisors, cases of crowding with lingual displacement of maxillary incisors, the adequate overjet is not present as in most cases of Class II malocclusion. In these cases, initial



Fig. 9.5: Basic components of Frankel II appliance buccal shields, lip pads, canine clasps, labial arch



Figs 9.6A and B: A. Herbst appliance for correction of Class II malocclusion; B. Occlusal view of the Herbst assembly (Courtesy: ORMCO)

orthodontic treatment to align the teeth and create the needed overjet is a must. Teeth should be retained in this position for a minimum of three months.

Then, accurate maxillary and mandibular impressions are taken covering most of the areas where the appliance would contact the soft tissues and poured immediately in stone. In the case of Herbst appliance, bands or crown should be transferred into the impressions first and then, the casts should be poured.

Construction Bite Registration

The final construction bite should represent the planned anterior and vertical and transverse position of the mandible.

- The inter-occlusal wax should be warmed enough so that it would permit indentations of all posterior teeth and then chilled to get the required hardness.
- The wax should not extend anteriorly to cover the incisors and should not extend posteriorly into the retro-molar area (as it might increase the vertical opening).
- 4-6 mm of forward positioning is acceptable by the patient and adequate for designing the appliance.
- The amount of inter-occlusal space required for wire and acrylic components determines the amount of downward positioning. Also, the requirement to restrict posterior eruption dictates that additional 2 mm of downward positioning would be necessary to extend the mandible beyond the resting vertical dimension.
- In the cases of mandibular skeletal asymmetry, the more deficient side should be advanced more forward.

Then, the stone models can be mounted in an articulator to confirm that wax bite represents the desired mandibular position. This is sent to the laboratory with specific instruction for fabrication of the appliance.

Delivery of the Functional Appliance

While delivering the appliance, the first check is that the appliance fits the soft tissue without impingement and the second step is to guide the patient in insertion and removal of the appliance till he is confident of doing so. Instruct the child that the appliance works only in the mouth, and not in the storage box. Hence, he should co-operate in the optimal wear of the removable appliance, i.e. 12-16 hours a day, to have best skeletal effect. As there would be initial discomfort like soft tissue sores, so the duration of wear should be gradually increased from 1-7 hours a day over the first week. Over the second week, the patient can wear it for another 3-5 hours.

Follow-up Appointments

1st follow up visit: 2 weeks after delivery of appliance to eliminate the difficulties of the patient and monitor the patient's adaptation to the appliance.

2nd follow up visit: A month after the first visit to check for the indicators of appliance wear like ease with which the patient inserts and removes the appliance and the antero-posterior improvement in occlusion.

Frequent follow up visits each at an interval of 2 months:

- Check for the decrease of overjet.
- Adjustments of the appliance.
 - Selective grinding of inter-occlusal acrylic for selective eruption of teeth.
 - Adjustments for wire elements to achieve selected dental movements.
 - Adjustments of labial bow.
 - Activation of expansion screws if they are incorporated in the appliance.
 - If additional advancement of mandible is required after 9-10 months of appliance wear, then replacement of the appliance with a new construction bite is suggested.

Effects on Dentition

The headgear has almost no effects on teeth other than maxillary posterior teeth but, functional appliances cause some retrusion of maxillary incisors by the lingual force from the labial bow. The mandible attempts to reposition itself in its original position and this produces a labial force from the lingual portion of the appliance and brings about protrusion of mandibular incisors. In case where maxillary anterior retraction is not required, the labial bow is positioned passively a little away from the incisors. Also, these appliances cause differential mandibular posterior eruption to correct Class II relationship and decrease anterior open bite. The headgears restrict maxillary growth but have best effects when mandible grows well. The functional appliances stimulate the mandibular growth but should cause a headgear like effect to restrict maxillary growth.

So, a combined orthopedic approach using headgears in combination with functional appliances would provide greater skeletal growth effects. But, this cannot be used with functional appliances with less acrylic bulk like FR or bionators. It can be used as occipital attachment connected to face bow that is inserted into headgear tubes incorporated in the acrylic of the functional appliance in the inter-occlusal area of the premolar region.

Inter-arch Traction

There are two types of inter-arch tractions:

Latex Elastic Traction-Class II Elastics

These are stretched from the anterior part of maxillary arch to the posterior part of mandibular arch. The antero-posterior effect of the elastics is protraction of the mandibular teeth and retraction of maxillary incisors. The vertical effect of elastics is extrusion of the mandibular posterior teeth

and maxillary anterior teeth resulting in rotation of the occlusal plane. The rubber elastics are placed and removed by the patient (Figs. 9.7A and B).

Indication for use of CI-II elastic traction in correction of skeletal CI-II malocclusion:

There should be some minimal mandibular growth potential with flat occlusal plane where an increase in lower facial height is desired.

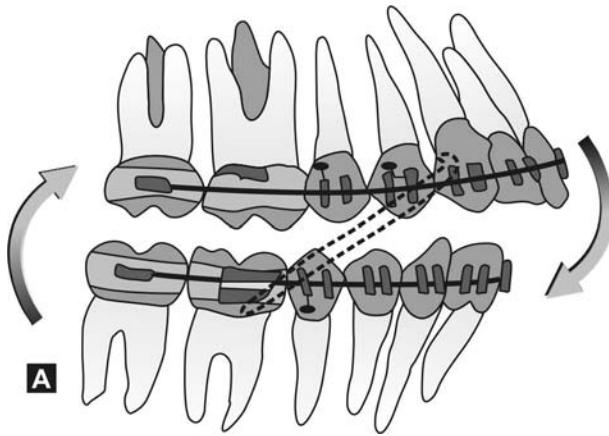


Fig. 9.7A: Class II elastics resulting in rotation of occlusal plane up in the posterior and down in the anterior region due to extrusion of mandibular posterior teeth and maxillary anterior teeth

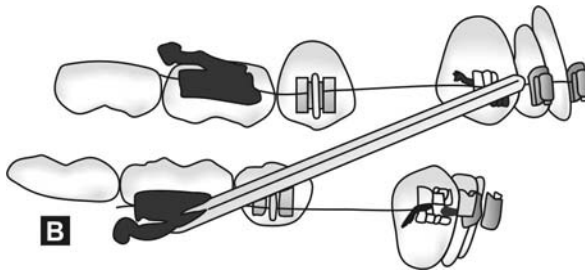


Fig. 9.7B: Class II elastics in the first stage of treatment with light wire systems in a typical Class II occlusion

Large Stainless Steel Springs

In contrast to the rubber elastics, these springs are ligated directly to the orthodontic appliance and can be removed only by the clinician. This is mainly used as an alternative resort when there is continued poor patient compliance with rubber elastics.

Intra-oral Preparation for CI-II Traction

Unlike headgears and functional appliances, Class II elastic traction should be used in adolescence with the presence of permanent dentition. This

should be used with a complete fixed orthodontic appliance and continuous arch wires in place. A full fixed appliance is indicated (and not only a 2" × 4" appliance) as there is a greater extrusive effect in the absence of adjacent teeth resisting the unwanted dental extrusion.

Before placement of CI-II elastics, it is important to achieve adequate alignment and leveling for teeth to slide along the arch wire in response to the horizontal force from the Class II elastics. Thus, initial flexible wires should be used followed by stiffer wires.

Delivery of Class II Elastics

Class II elastics are stretched between the maxillary points of attachment (that is the maxillary canine) and the mandibular points of attachment (that is the mandibular first molar). These points could be directly incorporated in the design of the brackets of these teeth or could be welded or soldered or bended into the arch wire. The magnitude of force required is between 100 gms to 300 gms per side depending on the number of teeth to be moved. Selection of size of the elastic has to be decided by the clinician. The elastics are available in two stipulated measurements:

- i. Inches or mm—cross section of the passive elastic.
- ii. Ounces or grams—force created by stretching the elastic to desired extent.

The patient is demonstrated to place and remove the elastic and then, encouraged to do this himself. The ideal wear should be 24 hrs/day except while cleaning the teeth or eating. Enough elastics should be given to the patient to replace them daily until the next visit.

Follow-up Appointments

1st follow up visit: This should be after 3-4 weeks of elastic delivery. The idea is to monitor the patient compliance and check for the progress of treatment.

2nd follow up visit: This should be 3-4 weeks after the first follow up visit. The idea is to check for bite opening antero-posterior dental corrections and adverse tipping of molars. If appreciable changes are not there, then remove the arch wires and restore bite opening bends, check the eating habits that distort the arch wire and educate the patient and parents and stress on the fact that wearing the elastics as prescribed is an absolute necessity. If there is adverse tipping of the molars, then check for a loose molar band and re-cement it, remove the arch wire and check the amount of anchor bends, replace a stiffer wire if required, and then dismiss the patient for six weeks and not examine him too soon.

Frequent follow up visits: Examine and follow up for complete fixed appliance therapy.

DENTAL CAMOUFLAGE OF SKELETAL CLASS II MALOCCLUSION

- Dental camouflage can be chosen only for mild to moderate skeletal Class II problems where camouflage would produce acceptable results

and not worsen the existing problem. This is best achieved in early years of permanent dentition with very little or no growth potential remaining or in the case of young adults with less severe skeletal problems.

- In this approach, we disguise the underlying unacceptable skeletal relationship by orthodontically repositioning the teeth in the jaws to an acceptable occlusion and esthetic appearance. Dental camouflage creates a dental compensation for a skeletal discrepancy; so, these are the cases where natural dental compensation has already taken place before orthodontic treatment (like proclined incisors).
- Also, patients chosen for dental camouflage should have minimal dental crowding or ideally, should have additional space in the dental arch. This is because if crowding or protrusion of incisors is very severe, most of the extraction space would be used up in alignment of anterior teeth and no additional space would be left to retract maxillary teeth or protract mandibular teeth.
- Finally, patients chosen for camouflage should have average or good facial proportions as dental movements do not completely work on unacceptable facial proportions.

Dental camouflage for skeletal problems can be chosen with extractions of teeth or without extractions of teeth.

Dental camouflage without dental extractions: The non-extraction approach aims at retracting the maxillary dentition and protracting the mandibular dentition to reduce the overjet and establishing normal posterior occlusal relationship. Therefore, either sufficient space should be already present in the dental arches or should be created orthodontically (without extractions) to permit successful camouflage. Thus, there are only two possible indications for this non-extraction approach:

- Generalized small dentition with excess inter-dental spaces in both the arches.
- Distal bodily movement of maxillary molars to provide space for retraction of maxillary anterior teeth and correct the molar relationship. In both the cases, bodily repositioning of teeth is required to achieve stable results. The pre-adjusted Edgewise appliance (fixed appliance) is best advocated for these cases to control the root movement. In the first case with excess inter-dental spaces in both the arches, the line of treatment is to retract maxillary teeth by providing maximum maxillary posterior anchorage and to protract mandibular teeth by providing maximum mandibular anterior anchorage. By doing so, normal posterior occlusion and overjet are achieved, accepting the mild underlying skeletal Class II condition.

Maxillary posterior anchorage is reinforced by one of these means:

- J hook headgear delivering a posteriorly directed force to the anterior teeth being retracted.
- Face bow delivering a posteriorly directed force to maxillary first molars.

- Posterior maxillary segment of teeth consolidated together into a single unit while retracting canines separately followed by incisor retraction.
- Use of CI-II elastics that utilize mandibular arch as resistance to provide maxillary retractive force.
- Transpalatal arch or Nance holding arch fixed to the maxillary first molars (Fig. 9.8).
- Use of absolute intra-oral anchorage with an osseo-integrated titanium implant in the palate to prevent reciprocal action of forces.

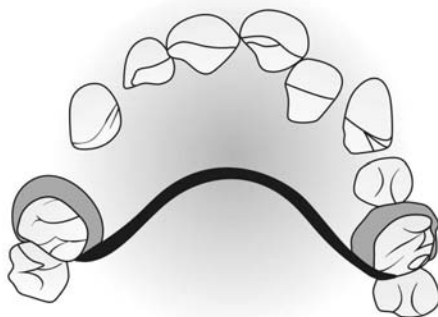


Fig. 9.8: Transpalatal holding arch

Mandibular anterior anchorage is reinforced by one of the following means:

- Lingual arch fixed to the mandibular canines.
- Anterior mandibular segment of teeth consolidated together into a single unit while protracting single posterior tooth one by one.
- Use of anteriorly directed extra-oral force, i.e. elastics extending from mandibular posterior teeth to the face mask.
- Use of CI-II elastics that utilize maxillary arch as resistance to provide mandibular protractive force.
- Use of absolute intra-oral anchorage within osseo-integrated implant distal to the mandibular molars.

Now, in the second case where adequate spacing is not there in the arches, maxillary posterior teeth should be moved distally to create space for anterior retraction. This requires distalization of maxillary first molars. The best method is a full time use of extra-oral force with a face bow attached to the first molars. But, most of the time, patients are not willing to wear this appliance on a full time basis. So, certain intra-oral orthodontic appliances can be placed to deliver distal force to the maxillary molars.

The best age for distalization is between 10-11 years when the second molars have not erupted. When the third molars are close to eruption, they should be removed before starting distalization as they impede the distal movement of first and second molars. In young adults also, it is recommended to extract the third molars before distalization of first and second molars has occurred.

Source of the intra-oral distalizing appliances are:

- The distal jet appliance; commercially available.
- Jones jig appliance.
- Preformed pendulum springs for pendulum appliance.
- Helical springs inserted into Nance holding arch.

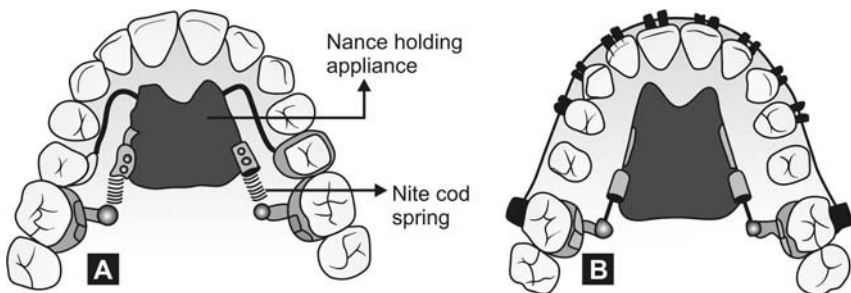
The Distal Jet Appliance

Appliance design and activation: It consists of 2 bilateral tubes embedded in acrylic Nance palatal button that is supported by attachments on the first or second premolars. The tube extends distally to the first molars, parallel to the occlusal plane and lies adjacent to the palatal tissues. A molar bayonet wire inserts into the lingual sheath of the molar band and extends into the tube as a piston. A nickel-titanium open coil spring is passed through this tube and piston arrangement along with an activation collar. This collar should be pushed distally once every six weeks so that it compresses the coil spring to generate distal force. There is a setscrew in each collar that should be locked onto the tube to maintain the force.

The calibrated force applied in adolescent children is 180 gms at the time of maximum activation. The calibrated force applied for upper molar distalization for adults is 240 gms at the time of maximum activation. Check the fit of distal jet before cementing it. Use the first premolars as anchor teeth as they require shorter connector arms to the Nance buttons and provide rigid support and stability. The second premolar naturally drifts along with molar distalization. Thus, there is not much need for active retraction. Initial activation should be done after cementation. The patient should be seen monthly during molar distalization. To reactivate the distal jet, loosen the screw, compress the spring and then, tighten the screw. The reactivation has to be followed till super Class I molar relation has been achieved. Usually, molars are distalized in 6-8 months and premolars are allowed to drift for 4 months. This has to be followed by anterior retraction. After the molar distalization has completed, the appliance should be converted into a passive Nance holding arch by opening the screw, decompressing the spring, removing the spring from the appliance with a weingart plier, locking the activation collar and creating a support from 1st molars to the Nance button (Fig. 9.9A and B).

Jones Jig Appliance for Maxillary Molar Distalization

This consists of an intra-oral buccally placed sectional jig assembly that utilizes Nitinol springs for maxillary molar distalization. Distalizing forces



Figs 9.9: A. Occlusal view of the distal jet appliance for molar distalization; B. After the molar distalization is completed, the distal jet appliance is converted to Nance holding arch

are constantly applied by the spring and this appliance requires very little cooperation from the patient.

To counteract the reciprocal forces to distally directed forces, the anchorage should be reinforced by the following means:

- Jig is connected to well adapted modified Nance palatal button and fully bracketed appliance.
- The Nance palatal button should be anchored to both first and second premolar to prevent anchorage loss.
- Friction free mechanics is used to distalize molars.
- Low force of 75 gm is delivered from Ni-Ti spring to prevent tipping of distalized molars and mesial movement of premolars (Fig. 9.10).

When molars are distalized sufficiently in around 5-6 months, the molars should be stabilized in their new position with a Nance holding arch and arch wire with molar stops. The premolars are allowed to drift distally, naturally by the pull of trans-septalfibres for 4-5 months.

The molars should not be used as anchorage for CI-I retractive forces for atleast 4-5 months after distalization as anchorage loss can easily occur. So, no retraction mechanics should be carried out during this time.



Fig. 9.10: Unilateral occlusal view of Jones Jig with Nance palatal button for molar distalization

Indications for both the appliances are:

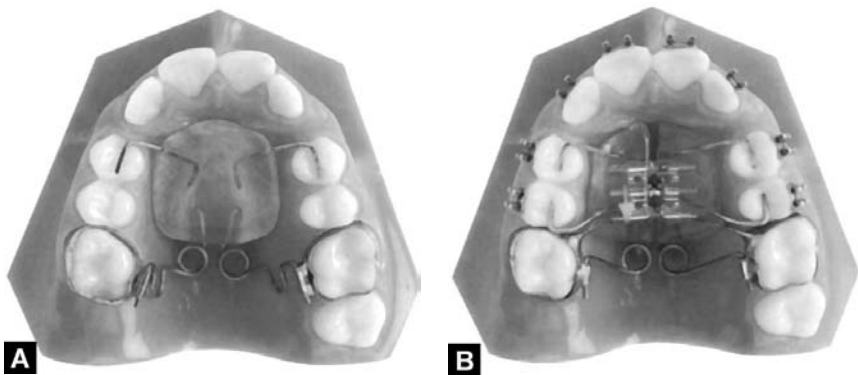
- Border line cases with discrepancy not more than 5-6 mm in upper arch.
- Mild or no crowding in lower arch.
- Normal mandibular plane angle.
- Patients with profiles that are straight or mildly convex.

Pendulum appliance is shown in Fig. 9.11A and B.

Dental camouflage with extraction of teeth

There are mainly two goals of this therapy as per the requirement of the case:

- To accept the Class II molar relationship but to achieve complete reduction of overjet. For this, usually, maxillary first molars are extracted. If the lower arch is well aligned, lower extractions can be avoided. But, if both the arches are not well aligned, then we can go for upper and lower 1st premolar extractions.
- To establish normal posterior occlusion and reduce the overjet in case of moderate discrepancy.
 - With moderate discrepancy in lower arch, we can extract lower 2nd premolars and upper 1st premolars so that the mandibular posterior teeth are moved forward to normal molar relationship.



Figs 9.11A and B: A. Pendulum appliance for molar distalization; (Courtesy: ORMO)
 B. Pendex appliance for combined palatal expansion and molar distalization
 (Courtesy: ORMCO)

- Comprehensive fixed orthodontic appliance is required to provide adequate control of both the arches. In any technique chosen, it is important to first level and align the teeth in each arch.

Closure of the Extraction Spaces in Begg's Technique

Dr Begg does not believe in distalization of molars as it is against the natural principle of mesial migration of posterior teeth. So, according to him, camouflage with extractions gives the most stable results. Moreover, in the Begg's technique, the forces are light and continuous and so, the first permanent molars are the only areas of anchorage (extra-oral anchorage is not required). Instead of closing the 1st premolar extraction spaces by first moving the canines bodily towards the extraction space and then moving 4 incisors bodily as in the Edgewise system, the crowns of six anterior teeth (upper and lower 12 anterior teeth) are simultaneously tipped back to rapidly close the extraction spaces without causing significant mesial movement of 1st permanent molars. The crowns of 2nd premolars become tipped mesially.

After the alignment and bite correction is done in the first stage of treatment, closure of remaining extraction space (some amount of space closure occurs during alignment) is done in the second stage of treatment. Stiffer 0.016 or 0.018 wires engaged towards the end of stage I are continued in this stage. Space closing horizontal (intra-maxillary) elastics extending along the buccal segments from inter-maxillary hooks to free distal ends of the area wire are used to close the extraction spaces. On each side, a light elastic is stretched that exerts 60-70 gm of force. By pass clamps on the 2nd premolar bracket guides the arch wire during posterior space closure.

During this stage, CI-II inter-maxillary elastics are continued to maintain antero-posterior relationship. All the teeth are up-righted during the third stage of treatment using torquing auxiliary and up-righting springs. The second stage would require approximately 2-4 months and the 3rd stage

would require 4-6 months for completion. At the end of the treatment, advise suitable retention appliance.

Closure of Extraction Spaces in Edgewise System

After initial alignment and leveling, gradual increase in stiffness of the wire (a minimum of 0.017 inch $\times$ 0.025 inch in 0.022 inch $\times$ 0.028 inch slot) is desired. Then, the principles of reinforcing anchorage are used (i.e. maximum maxillary posterior anchorage and maximum mandibular anterior anchorage). Usually, canines are retracted first and then the four incisors are retracted. The canines are joined to the posterior teeth after their retraction and this unit is pitted against the four maxillary incisors to obtain maximum retraction. Also, use Class-II elastics and use mandibular teeth as anchorage to produce maximum retraction of the maxillary incisors.

Surgical Correction of CI-II Skeletal Malocclusion in Adults

Severe skeletal conditions with no growth potential are indicated to be treated in adults by combined surgical and orthodontic correction. The following surgical procedures could be the options for treatment:

- Mandibular advancement
- Mandibular total sub-apical advancement
- Total maxillary osteotomy when there is vertical maxillary excess in both anterior and posterior segment
- Segmental maxillary osteotomy when there is vertical maxillary excess posteriorly
- Combined mandibular advancement and maxillary set back (refer to chapter 7).

The malocclusions in which there is a mesial relationship of the mandible to the maxilla are termed as Class III malocclusions. According to Angel's classification, Class III malocclusions are those in which the mesial groove of the mandibular first permanent molar articulates anterior to the mesiobuccal cusp of maxillary first permanent molar. Inheritance, oral habits, occlusal prematurities, or early loss of upper deciduous molars are the main etiological reasons for the occurrence of Class III malocclusion.

Differentiating Class III Malocclusions

To plan out the treatment possibilities, it is important to evaluate whether the problem is dentoalveolar or skeletal in origin. In dentoalveolar Class III malocclusion, the skeletal relationship is normal but the condition is caused by the lingual tipping of the maxillary incisors and labial tipping of the mandibular incisors. Thus, a negative overjet is present. This requires functional assessment of the movement of the mandible to determine whether the condition is due to dental inclinations or there is a pseudo Class III malocclusion. Patients who are able to shift the mandible upon closure to a Class I molar relation in centric relation (CR) but have a Class III molar and jaw relation upon central occlusion (CO) have a pseudo Class III malocclusion. They habitually protrude the mandible for better posterior intercuspation.

In skeletal Class III malocclusion, there is a definite underlying jaw discrepancy leading to the dental malocclusion.

The skeletal Class III malocclusions may comprise of the following jaw discrepancies:

- i. Underdeveloped maxilla
 - Retrognathic maxilla
 - Mandible may be normal in size.
 - Profile is concave.
- ii. Overdeveloped mandible
 - Overdevelopment of mandible in relation to maxilla.
 - Maxilla may be normal in size.
 - Profile is flat or concave reflecting the hyperdevelopment of the lower third of the face rather than the underdevelopment of the middle third of the face.

- iii. Combination of both
 - Retrognathic maxilla
 - Prognathic mandible

Objectives of Class III treatment

- i. Improvement of soft tissue profile
- ii. Improvement of dental and facial esthetics
- iii. Correction of anterior cross bite
- iv. Correction of posterior cross bite
- v. Leveling of bite
- vi. Correction of posterior segment relationship.

Ideal Time to Start Treatment of Class III Malocclusion

If a clinician encounters a developing Class III malocclusion during the early childhood, it should be intercepted early so that more favorable environment for future growth can be provided. The best time to start this interceptive therapy is when the permanent incisors erupt in the mixed dentition period so that developing anterior cross bite can also be dealt with in the same treatment procedure.

But to select a patient for early interceptive treatment, the following rationale has to be considered:

"The child should have mild skeletal disharmony, symmetric condylar growth, anteroposterior shift, good growth potential and excellent cooperative abilities".

Treatment can be delayed until growth completion for a child who has very severe skeletal disharmony, genetic predisposition, asymmetric growth, no anteroposterior shift, poor growth potential and poor expected cooperation. These patients might require surgery after initial orthodontic treatment.

Treatment of Pseudo Class III Malocclusion

This condition usually arises as a result of premature tooth contacts in the cases of early loss of deciduous upper posteriors leading to functional shift of mandible to get better occlusal contacts. This leads to CO-CR discrepancy. If this is left undiagnosed, it would have adverse growth effects on the maxilla and mandible. Thus, detect the CO-CR discrepancy by assessment of mandibular function and then eliminate it in the following way:

- i. Evaluate the occlusal prematurities and provide occlusal rehabilitation.
- ii. Provide functional space maintainers for loss of upper posterior teeth.

Treatment of True Class III Malocclusion

True Class III malocclusion could be dentoalveolar or skeletal in nature. Usually, treatment should be best avoided in deciduous dentition period except for early correction of skeletal discrepancy by orthopedic forces. But here, there might be poor patient compliance.

Treatment during Mixed Dentition

- i. *Correction of dentoalveolar Class III malocclusion:* This is mainly limited to correction of anterior cross bite.

The means like anterior expansion, 'Z' springs, tongue blade therapy, anterior cemented inclined planes, compomer inclined planes are used as interceptive means to correct developing anterior cross bites in mixed dentition. If not corrected for a long time, then these would have adverse effect on the jaw growth and the problem becomes more severe. This has been discussed in the chapter on Interceptive orthodontics.

- ii. *Correction of skeletal Class III malocclusion:*

- a. *Myofunctional appliance therapy:* The functional correction of Class III malocclusion is achieved by correcting arch relationships by encouraging maxillary advancement and restricting the forward mandibular development. Highly advantageous treatment can be completed in this young age because of the active cellular response to pressures from various appliances. Patients with some degree of initial anterior mandibular shift and a moderate overbite have a better prognosis with functional appliances.

- Working bite for Class III functional appliance: Construction of the bite is same as that for Class II except for one major difference. Mandible is rotated open on its hinge axis but not advanced. This bite directs light forces on the chin point to retrude the mandible. The amount of mandibular opening depends on the need to interpose bite blocks or occlusal stops between the teeth.
- The Frankel III (FR-III) regulator is used for skeletal Class III correction as it counteracts the muscle forces acting on the maxillary complex (Fig.10.1). The vestibular shields in the sulcus depth are placed away from the alveolar buccal plates of the maxilla to stretch the periosteum and encourage forward development of maxilla. But the shields are closely fitted to the alveolar process of the mandible to redirect its growth posteriorly. A full time appliance wear is expected from the patient to get desired results. The mandible is positioned downward and backward increasing

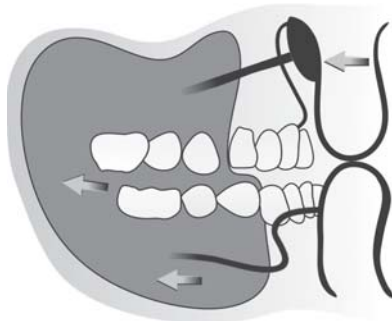


Fig.10.1: Schematic presentation of Frankel III appliance showing that the pressure from upper lip is prevented by the upper lip pads and the pressure from the lower lip is transmitted through the appliance to the mandible due to the close fit of the appliance with the mandibular arch

the lower facial height. Hence, as mentioned earlier, patients with a moderate overbite (4 to 5 mm) should be selected for FR-III therapy.

- Reverse 'Twin Block' appliances and reverse 'Bionators' have also been used and recommended to correct developing CI-III relationship. Reverse fixed twin blocks have been tried by clinicians and have found their use advantageous as they eliminate the need of patient compliance with the appliance wear. Here the correction of Class III malocclusion is achieved by occlusal forces that act as functional mechanism in correcting the arch relationship. The bite is hinged open with the condyles down and forward in the fossae and the inclined planes are directed downwards and backwards on the mandibular teeth.
- b. *Maxillofacial orthopedic appliances*: In dentofacial orthopedics, there is presence of dental malocclusion along with an underlying skeletal imbalance. The primary aim is to correct the skeletal imbalance while the correction of dental malocclusion is of secondary importance.

The orthopedic appliances act directly at the skeletal level so that dentoalveolar compensation for maxillomandibular discrepancy might not result in unacceptable results like resorbed roots, sheared alveolar crest, unstable tooth positions that are out of harmony with the neuromuscular and the bone system. Hence, by attacking the problem at the basal bone level, therapeutic demands within the tooth system itself would be less vigorous and more likely to be stable after treatment.

General considerations for orthopedic treatment in correction of Class III discrepancy

- i. Many patients have an increased lower vertical face height with an open bite. In these patients, Class III elastics and second order (Edgewise) bends in the posterior region cannot be used conveniently because of extrusive force components on the posterior, further worsening the skeletal condition. Also, Class III elastics can extrude mandibular incisors and there is frequently excessive vertical dentoalveolar development in the incisor region. Thus, the cases where there are limitations in treatment with conventional orthodontic procedures, extra-oral traction with orthopedic appliances should be considered as the needful force system and can be placed for precise results with few deleterious effects.
- ii. Early interceptive dentofacial orthopedic procedures are desirable at an age of 3 to 4 years because of greater tissue adaptability at this age. The first phase of treatment may last for 8 to 12 months, which corrects the severity of the skeletal discrepancy. The second phase of treatment can begin just before the exfoliation of second deciduous molars.

Treatment of Skeletal Class III with Underdeveloped Maxilla

- Treatment can be started as early as 4 years.
- Extraoral traction pulls the maxilla anteriorly and functions in the same direction as the direction of development.
- Orthopedic appliances used for this are expected to achieve the following desirable effects:
 - i. Protraction of maxilla with a strong orthopedic force (500-1000 gms/side).
 - ii. Increasing the inclination of maxillary incisors to obtain sufficient overjet.
 - iii. Bodily movement of all teeth in a mesial direction.
 - iv. Better function and esthetics.

Appliances Used

- i. *Reverse headgear or protraction headgear*: Design and activation: This uses some form of chin cup along with a modified headgear for protraction. There is an intraoral headgear bow in which a U-shaped loop is made at the end of the bow to insert it from the distal end of the maxillary molar headgear tube. The outer bow is placed according to the desired movement of the maxilla in relation to the center of rotation of the maxillary dentition, which is tied together as one unit by a heavy 0.019×0.025 stabilizing arch wire. The appliance is activated by means of elastics from the outer bow to the wires of the chin cup. Elastics deliver a force of 500 to 1000 gm/side when worn for around 20 hours per day.
- ii. *Protraction face mask of Delaire*: This is placed against 2 areas of the face, the forehead and the chin. The objective is to produce anterior movement of maxilla and these areas give excellent anchorage.

Design and activation: There is an adjustable interior wire with hooks connected to the midline framework to accommodate downward and forward pull of the maxilla. Protraction elastics are used to deliver this force and they are attached near the maxillary canines with a downward and forward pull. These elastics produce a strong force of 500 gm per side (Fig.10.2). A retrognathic maxilla is often associated with a narrow maxillary arch producing bilateral cross bite.



Fig.10.2: Protraction face mask
(Courtesy: Ortho organizers)

Hence, expansion of the arches can be done simultaneously with protraction or before starting the protraction. In milder case, a removable screw plate with expansion jackscrew in midline is used. In severe cases, rapid palatal expansion is done to expand the maxillary arch laterally. Clinical research shows that greater forward movement of the maxilla occurs when protraction is done in conjunction with palatal expansion. Also, palatal expansion is done to disarticulate the maxilla to produce more positive reaction to protraction forces. This part has been discussed in detail in the chapter on "Cross Bite".

The appliance can produce desirable results in 4 to 12 months with 12 to 14 hours of appliance wear per day.

The cases should be over-treated to CI-II relationship with any of the above appliance and then should be retained with FR-III for at least 1 year.

Treatment of Skeletal Class III with Over-developed Mandible

The objective of the appliances is to restrict horizontal mandibular growth or redirect it into more vertical direction. Appliances used are:

- i. Chin cup therapy
- ii. Extraoral traction

Chin up therapy

Objective of this therapy: The orthopedic effects of chin cup on the mandible include (a) vertical redirection of mandibular growth, (b) backward rotation of the mandible, (c) remodeling of the mandible with decrease in mandible angle. Orthopedic effects of chin cup on the maxilla include prevention of retardation of anteroposterior maxillary growth by early correction of cross bite by chin cup therapy.

Best timing of starting chin cup therapy: Clinical research shows that reduction of mandibular protrusion is more successful when it is started in primary or early mixed dentition period. Duration of treatment varies from 1 to 3 years depending on the severity of the malocclusion.

Appliance design and force application: Chin cup assembly consists of a chin cup that covers the chin, a head cap and an elastic strap with spring mechanism that connects chin cup with the head cap. Usually, an impression of the chin is made and a hard chin cup can be custom fitted from plastic or acrylic or a commercial metal or plastic chin cup can be chosen to fit well to the chin area. The appliance produces lingual movement of lower incisors by pressure of the chin cup. It is attached to a head cap by means of a spring mechanism, which can be adjusted to direct a force of 16 to 24 ounces per side through the head of the condyle or a somewhat lighter force below the condyle.

Duration of appliance wear: At least 12 to 14 hours of wear per day produces desired results.

The *occipital pull chin cup* is most commonly used for treatment of CI-III. The occipital region of the head provides the anchorage. It is chosen for patients with mild to moderate mandibular prognathism in patients who can bring their incisors edge to edge or patients with protrusive lower incisors. The *vertical pull chin up* derives its anchorage from the parietal region of the head and is used in patients with a steep mandibular plane and an open bite.

Effects of treatment: Treatment effects are very much similar to those of Class III functional appliances, i.e. mandible is rotated downwards and backwards to a less prominent position, maxillary incisors move labially and mandibular incisors tip lingually.

Thus the ideal choice of patients for this therapy includes

- Children with normal or reduced lower anterior face height.
- Children with protruded or straight mandibular incisors and not with retruded mandibular incisors.

Extraoral traction With this appliance, we expect to achieve the following objectives:

- Repositioning of the mandible posteriorly so that the condyle enters the glenoid fossa.
- Better control of vertical dimension.
- Orthodontic movement by inclining the lower teeth posteriorly.
- Retarding the mandibular growth potential to some extent.

We can apply two types of extra-oral traction to the lower arch:

- Cervical pull traction: Face bow is attached to the lower molars. Kloehe type of face bow is placed against lower 1st molar in Class III cases with deep bite.
- Facial wires are placed against the incisor segment by means of 'J' hooks on the arch wires.

This type of extra-oral traction is indicated when a lower removable appliance is used in early or mixed dentition period. Hooks are incorporated in the plate anteriorly to engage the facial wires of the headgear.

The force can be placed directly against the lower first molars by incorporating molar stops in the arch wire. This is useful when lower deciduous second molar has exfoliated and lower second premolar is erupting.

Lower molars can be moved distally and mandibular incisors can also be retracted without straining anchorage.

Treatment of Skeletal Class III with Combination of Retrognathic Maxilla and Prognathic Mandible

In such cases (like in cleft palate Class III cases), the problem is attacked simultaneously in both the jaws.

Appliances used in the case of modified chin cup with extraoral traction: The chin up is modified by adding 2 vertical arms for elastics, which connect up with a maxillary intraoral appliance. Extraoral traction can also be used to stimulate protraction of maxilla. Initially, a protraction facemask or reverse headgear can be used. Later, extraoral appliances with 'J' hooks can be used to move mandibular arch distally.

Treatment of Class III during Adolescence and in Nongrowing Patients

Camouflage can be used in patients with very mild skeletal Class III problems where adjustment of incisor position can achieve acceptable occlusion and reasonably good esthetics. This requires comprehensive orthodontic treatment with fixed appliances in the permanent dentition. Comprehensive orthodontic treatment in adolescence can also be done as a phase II treatment after the first phase of growth modification is done in mixed dentition period.

For camouflage of Class III skeletal discrepancies, CI-III intermaxillary elastics are used with or without extraction of teeth. Class III intermaxillary elastics are engaged from upper molar area to lower canine area (Fig.10.3). These elastics have an extrusive component and extrude upper molars and lower incisors. Elongating the upper molars within acceptable limits would rotate the mandible downward and backward, which is favorable in treatment of Class III problem.

Dr Begg advocated a simple treatment approach for treatment of mild skeletal Class III where the arch length discrepancy as well as jaw discrepancy is mild and extraction of teeth is not required. Initial alignment of teeth can be done with flexible wires. When initial alignment is achieved, the typical Class III arch wires can be formed as follows:

Wider upper arch wire (0.016 Australian) with distal ends wide apart is used to expand the upper buccal segments. Molar stops can be incorporated in the wire on both the sides to prevent retraction of the maxillary teeth. In the lower arch, the plain arch wire can be engaged. Class III intermaxillary elastics can be engaged from the lower intermaxillary hook to upper first molar hook. Class III elastic force would tip

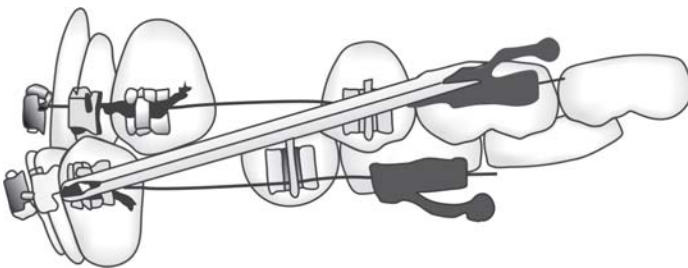


Fig.10.3: Class III intermaxillary elastics

the upper incisors into good labial inclination and lower incisors would be tipped lingually.

In the third stage, a lower auxiliary arch wire with vertical spurs can be used to correct the axial relations of lower incisors. Also, anterior vertical intermaxillary elastics can be worn to increase the depth of anterior over bite to assist in the post-treatment stability of occlusion. A Begg acrylic retainer with a circumferential wire extending from behind the second permanent molar and touching the teeth against external surfaces of all upper teeth can be worn for a period of 6 months to 1 year following appliance removal (active treatment time in such nonextraction cases can be 12 to 15 months). A Hawley type retention plate can be worn in lower arch.

Various extraction schemes can be used to treat Class III cases with mildly protruded mandible and upper and lower crowding:

- When there is arch length discrepancy in both the arches, extractions can be carried out in both the arches, like all four 1st premolar extractions or extraction of maxillary 2nd premolars and mandibular 1st premolars for maximum anterior mandibular retraction.
- When crowding is not a problem in the upper arch, we can carry out expansion of upper arch in the anteroposterior direction and retraction of lower anterior teeth with two lower premolar extractions.

In the case of upper extractions, most of the extraction space is closed during the first stage of treatment. The extraction space is utilized for expansion of arch and alignment of teeth. Lower extraction space needs to be closed by retracting lower anterior teeth with horizontal elastics. Usually, Class III relations are corrected during the first stage of treatment. Then, during 2nd and 3rd stage of treatment, Class III elastics can be used judiciously to control excessive molar extrusion. Roots of upper incisors can be torqued labially by vertical root torquing spurs (that point down incisally from main arch wire) during the 3rd stage of treatment. Up-righting of canines and premolars adjacent to the extraction site is also done during the third stage of treatment.

Similarly, Class III treatment can also be done with edgewise appliance. Excessive molar extrusion by CI-III elastics can be controlled by high pull headgear. Principles of reinforcing the required anchorage should be followed. High pull headgear to the upper molars can be worn along with Class III elastics to control the amount of upper molar elongation.

Treatment of severe Class III skeletal discrepancy after active growth by combined orthodontic and orthognathic surgery.

Patients with severe Class III malocclusion with mandibular prognathism, maxillary retrusion with a divergent facial pattern where active growth is completed, have only one option of going for combined orthodontic and surgical approach. To ensure that active growth has completed after puberty, two lateral cephalograms are taken at interval of one year to find out that no significant growth has occurred during that period.

The most common surgical procedures used are:

- LeFort I osteotomy of maxilla to anteriorly reposition the maxilla.
- Surgical segmentation of maxilla to allow transverse expansion.
- Ramus osteotomy to set back prognathic mandible.
- Mandibular inferior border osteotomy to reduce chin prominence.

For detailed description, one should refer to chapter on "Surgical Orthodontics".

11

Treatment of Midline Diastema

Space or gap existing in the midline of the dental arch is termed as *Midline Diastema*. Generally, the term is used in reference to the maxillary arch, but midline diastema could also be present in the mandibular arch. Usually, the space exists between the two central incisors.

Midline diastema is a physiologic manifestation during the deciduous dentition and also during the ugly duckling stage before the eruption of the permanent canines. Midline diastema present in the deciduous dentition do not require any treatment as they are positive indicators of the adequate space present for the eruption of succedaneous permanent teeth. Midline diastema may appear in the ugly duckling stage, which is the mixed dentition stage during the age group of 8-10 years. There is an ugly arrangement of anterior teeth, which is a transient phase of development. The developing permanent upper canines cause mesial displacement of the roots of permanent incisors, which, in turn, causes a distal flaring of the crowns of the permanent incisor. This is automatically corrected when the canines erupt. But in the permanent dentition, diastema between central incisors may occur for various reasons. It is important to understand the cause of the particular condition in order to undertake its proper treatment.

These causes could be:

1. The incisors are of a normal or smaller size, but the dental arch is larger.
2. The incisors have a smaller size and dental arch is normal, e.g. *microdontia*, which is most commonly associated with peg shaped lateral incisors.
3. A midline frenum is attached at improper site to the soft and bony tissues. A normal frenum is attached to the gingiva superior to the central incisors. Abnormal frenum attachment could be
 - a. A high labial frenum that attaches to the incisive papilla or to the palatal soft tissues lingual to the incisors.
 - b. A wide and fibrous frenum at the site of attachment, which prevents approximation of the two central incisors.

To detect the abnormal frenum, the *Blanch test* could be used. When the upper lip and the frenum are stretched, the tissue between the central incisors moves and gets blanched.

4. Presence of supernumerary teeth in the midline or presence of cystic lesions or other pathologies in the midline.

5. Congenital absence of lateral incisor: This leads to distal drifting of the central incisors in the available space leading to midline diastema.
6. One or more incisors are severely rotated. Rotation around 90 degrees from the normal position would exhibit space between the incisors.
7. Deleterious oral habits like thumb or digit sucking, anterior tongue thrust, etc. give abnormal pressure to the anterior teeth leading to their anterior proclination along the spacing in between them.
8. Pathological condition like *juvenile periodontitis* or *periodontal weakness* in adults.

FACTORS TO BE CONSIDERED IN THE TREATMENT OF MIDLINE DIASTEMA

Size of Teeth

The mesiodistal widths of the anterior teeth and the arch width should be measured. These measurements should be compared with the norms to determine whether it is contributed due to tooth size or arch size discrepancy. If it is contributed due to tooth size discrepancy, check whether all four incisors are small or only the lateral incisors are smaller with normal sized central incisors. Approximate mesiodistal widths of anterior teeth and approximate arch widths, both in mm, are given in Tables 11.1 and 11.2 respectively. If only the lateral incisors are small, the diastema should be closed orthodontically by moving the central incisor together reciprocally. Then the lateral incisor positions can be corrected orthodontically and tooth size can be restored by composite build up or placement of crowns over lateral incisors.

Inter-arch Relationship

When the combined width of the mandibular anterior teeth is very large and the combined mesiodistal width of the maxillary teeth is less, then the lower arch is well aligned but it does not relate with the upper arch. Thus, labial positioning of the upper anterior with spacing in-between upper teeth presents to match the upper arch with the well-aligned lower arch. Such a

Table 11.1: Approximate mesiodistal widths of anterior teeth according to a reliable survey in patients with normal occlusion (in mm)

<i>Maxillary Arch</i>	<i>Central Incisor</i>	<i>Lateral Incisor</i>	<i>Canine</i>
Male	9.4	7.5	8.8
Female	9.3	7.3	8.2
<i>Mandibular Arch</i>			
Male	6	6.4	7.4
Female	6	6.3	7.1

Table 11.2: Approximate values of arch widths according to a reliable survey in patients with normal occlusion (in mm)

<i>Arch width</i>	<i>Male</i>	<i>Female</i>
Maxillary Inter-canine	36 ± 2.5	33 ± 1.6
Mandibular Inter-canine	26 ± 2.1	25 ± 1.8
Maxillary Inter-molar	54 ± 2.8	50 ± 2.2
Mandibular Inter-molar	53 ± 1.7	50 ± 1.1

case would require inter-proximal enamel reduction from lower anterior teeth or extractions of lower second premolars followed by fixed orthodontic appliances in both the arches. After the spaces are closed in the lower arch, the maxillary incisors should be brought together reciprocally.

In another case, if spaces exist between both maxillary and mandibular teeth, the spaces in the lower arch should be closed first and then, the maxillary incisors should be retracted. This would reduce or eliminate the diastema in the maxillary arch.

Position of the Maxillary Incisors

Sometimes, maxillary incisors are labially inclined with the presence of diastemas between them. This could result from a prolonged oral habit like thumb sucking and/or tongue thrusting. If the habit actively persists when the patient reports for orthodontic treatment, it should be addressed as the first phase of orthodontic treatment. After the elimination of the habit, orthodontic correction is commenced.

When the over jet is excessive, the incisors should be retracted using any of the fixed or removable appliances. Use of fixed Edgewise appliance would result in good bodily movement of teeth with good final finishing. Retraction of incisors in itself could close the diastema. But if diastema still persists even after incisor retraction, treatment should be directed towards redistribution of space followed by esthetic enlargement. Porcelain or composite veneers or crowns could be used for esthetic enlargement of teeth to counteract the tooth material deficiency after completing the orthodontic treatment.

Sometimes, the incisors are badly rotated giving appearance of diastemas. Orthodontic de-rotation of these teeth would automatically eliminate the diastema. But the retention of these rotations requires supra-crestal fibrotomy around the tooth and fixed retainers.

Presence of Tooth Anomalies and Other Pathologic Lesions in the Soft or Hard Tissue in the Midline

Generally, mesiodens is present as a supernumerary tooth in the hard or soft tissue and acts as an impediment in the eruption of permanent central incisors in their correct position and also, approximation of these teeth is not possible because of its presence. Again, any fibrous cystic or bony lesion may also be present. Radiographic assessment with Intra-oral Periapical X-rays and upper occlusal views are recommended. Extraction of supernumerary tooth should be carried out before commencing orthodontic treatment. Surgical excision in the case of pathological lesion is necessarily done and zinc oxide eugenol dressing for two weeks is placed post-surgical at the site of the surgery. Orthodontic correction should follow the removal of the pathologic cause.

Pressure of Abnormal Maxillary Labial Frenum

An abnormally attached maxillary labial frenum or a heavy fibrous frenum between the central incisors complicates the correction of midline diastema. *Frenectomy* is a must for orthodontic correction, esthetics, and stability of the final result and it should be well co-ordinated with orthodontic treatment. A popular belief is that if frenum is removed before tooth movement, then scar tissue forms between the teeth as healing occurs, which impedes the closure of diastema. Also, a prolonged delay of tooth movement after surgery may result in a space that is even more difficult to close. Hence, it is preferred by most clinicians to orthodontically close the diastema before frenectomy. In case, the diastema is very large and the frenal attachment is very thick, it might not be possible to close the space completely before the surgical removal of the tissue. In this case, partial space closure should be done orthodontically followed by frenectomy. Remaining orthodontic correction should resume immediately. This brings the teeth together quickly and healing occurs when the space is closed. Thus, the post-surgical scar stabilizes the orthodontic correction instead of complicating it.

Frenectomy procedure is explained in the chapter on "Surgical Orthodontics".

In these cases, sliding mechanics for space closure should be used instead of loop mechanics. This maxillary midline diastema tends to recur after treatment because of elastic gingival fiber network. Hence, a bonded lingual fixed retainer is always recommended.

Timing of Orthodontic Management for Midline Diastema

Closure of midline diastema is not indicated during deciduous dentition phase or the ugly duckling mixed dentition phase. In the mixed dentition, there are two main indications for a midline diastema:

- a. Esthetic complaint
- b. Positioning of central incisors that inhibit eruption of lateral incisor or canines.

In such a case, if the diastema is less than 2 mm, it can be closed using a removable appliance, as these incisors do not require bodily movement. Tipping movement of the incisors would be sufficient to close the space. If the unesthetic diastema is larger than 2 mm, bodily mesiodistal repositioning of incisors is required. This can be achieved by using sliding mechanics with fixed appliances.

In the permanent dentition, esthetic complaint is the major reason for seeking orthodontic correction. In adults, loss of posterior teeth, small sized teeth, or periodontal weakness may cause drifting of all teeth and anterior diastema between incisors. These cases might require partial closure of maxillary incisor spacing and redistribution of the remaining diastema space, followed by esthetic restorative procedures or replacement of missing teeth.

Periodontal Status

The amount of bone support for each tooth should be of special consideration in children with *juvenile periodontitis* and adults with *periodontal problems*. Localized juvenile periodontitis is an aggressive periodontal disease, which is seen in teenagers. It is characterized by loss of tissue attachment and loss of alveolar bone around the permanent incisors and first molars. One sees a distolabial migration of the maxillary incisors as a result of excessive bone loss forming a midline diastema.

The first line of treatment is to control the disease by periodontal therapy like scaling, root planing and with anti-microbial agents like tetracycline and metrogyl. In most cases, consultation with a periodontist is a must. A close collaboration between the orthodontist and the periodontist is desirable. Ideally, the treatment of juvenile periodontitis should include correction of systemic conditions along with the localized measures. In advanced stages of the disease, it is difficult to retain the teeth in function but in early stages, the disease can be eliminated and the dentition can be retained. The only contraindication to orthodontic treatment for this is persistence of gingival inflammation and severe bone loss in spite of adequate phase I periodontal therapy, which includes preparation of tooth surface, plaque control, anti-microbial agents, and control of uncomplicated gingivitis. In adults seeking orthodontic closure of anterior spacing, it is assumed that the bone remodeling process may occur more slowly. So, for both teenagers with initial stages of LJP and adults with or without periodontal problem, phase I periodontal therapy procedures are finished first, preferably by a periodontist. Orthodontic treatment should be started only after the inflammation of the gingiva has reduced to a minimum by the phase I periodontal therapy.

Major occlusal adjustments and periodontal surgical procedures are performed after completion of orthodontic space closure as firstly, orthodontics may change the shape of periodontium reducing the extent of surgery and secondly, the removal of supra-crestal fibers during surgery will facilitate retention. Generally, to correct pathologic tooth migrations of anterior teeth, a tissue-borne removable appliance with a labial wire or light elastics attached to the hooks embedded in the acrylic at the distal surface of each canine is used. These elastics are engaged below the brackets or buttons on the incisors. This would produce light and intermittent forces that would intrude as well as retract the anterior teeth closing the diastema. These light and intermittent forces are ideal for the closure of diastemas created by pathologic migration of anterior teeth.

In adult patients, when there is loss of periodontal attachment, surface area of supported root becomes smaller and the center of resistance also becomes further. So, for tooth movement, light forces with relatively large moments are needed.

Hence, each case of midline diastema is different with different etiological reasons and different factors affecting the treatment plan. Thus,

a stepwise management of midline diastema as given below, should be taken up.

- i. First, eliminate the cause.
- ii. Decide a treatment plan with the selected appliance design as per the factors discussed earlier. The appliances could be removable or fixed appliances.

Removable appliances:

- a. Hawley's plate with finger springs
- b. Hawley's plate with finger springs along with labial bow
- c. Acrylic plate with split labial bow

Fixed appliances:

- a. Beggs appliance
- b. Edgewise appliance
- c. Combination of Beggs and Edgewise appliance
- iii. *Plan a retention appliance suitable for individual case:* A removable Hawley type retainer is good for retaining the closure of diastema if the diastema is not complicated and is less than 2 mm. But a prolonged wear of the retention appliance would be required. In diastemas greater than 2 mm, fixed retainers are indicated to maintain the space closure achieved by orthodontic treatment. Even after a frenectomy, there is always a tendency for a little space to open up between the two central incisors. Semi-permanently or permanently bonded retention is needed.

A section of flexible wire is contoured so that it lies near the gingulum to keep it out of occlusal contact and then, bonded in this area. This retention with a flexible wire would hold the teeth together while allowing some independent movement of teeth during function. Preformed steel bondage retainers are also available. In troublesome diastema cases, it would not be wise to use removable retainers as the space would open up quickly when the retainer is removed.

APPLIANCES USED IN THE TREATMENT OF MIDLINE DIASTEMA

Removable appliances: These are used in two conditions; (a) when the diastema is small (less than 2 mm) and uncomplicated where tipping of crowns could close the space and bodily or root movement of incisors is not required; (b) when diastema is created because of pathologic migration of teeth when the forces are absolutely light. As discussed earlier, these appliances are:

- a. *Hawley appliance with two finger springs*
 - Clasps on the molars and premolars.
 - Two finger springs placed distal to the 2 central incisors. Finger springs are 0.5 to 0.6 mm diameter wire. These can be activated and small diastemas can be closed within six months (Fig. 11.1).
- b. *Hawley appliance with finger springs along with labial bow*
 - Clasps on molars and premolars.
 - Two finger springs distal to the central incisors

- Labial from canine to canine.

The central incisors are brought together by activating the finger springs. The remaining anterior spaces are closed and the teeth are retracted by activating the loops of the labial bow. Labial bow is made from 0.7 mm stainless steel wire.

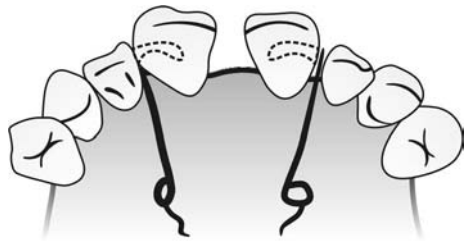


Fig. 11.1: Upper removable appliance with finger springs for mesial movement of incisors. Note that the finger spring is made of a helix near the point of attachment and a free end, which can be activated for movement in an arc

c. *Acrylic plate with split labial bow*

- Clasps (Adams or C clasps, pin head clasps) on molars and premolars.

- 2 split labial bows with U loop on canine of one side extending till the lateral incisor of other side. Both

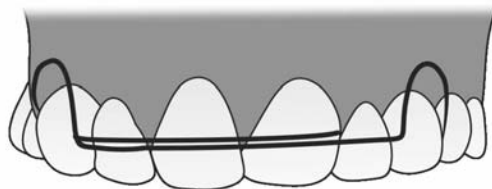


Fig. 11.2: Upper removable appliance with split labial bow for closure of midline space

the U loops are activated for simultaneous closure of all anterior spaces (Fig.11.2).

FIXED ORTHODONTIC APPLIANCES

These are used when the diastemas are larger than 2 mm, are complicated and when both the arches are involved in the malocclusion.

BEGG'S FIXED APPLIANCE IN THE CLOSURE OF ANTERIOR SPACES AND MIDLINE DIASTEMA

First Stage

1. Align all the teeth by use of 0.016 Nite wires, looped arch wires or very light Australian wires like 0.012 or 0.014. The irregularities of the upper incisors should be corrected and rotation of upper incisors should be overcorrected. If both the arches are used for appliance placement, both upper and lower arch wires should be carefully shaped so that both the dental arch forms become well coordinated with each other.
2. Plain 0.016 Australian wires with anchor bends and inter-maxillary circles, not contacting the mesial part of the canine bracket slot but having contacts with inter-maxillary circles that are much more mesially placed (short inter-maxillary circles), are used to replace the initial wires. Very small latex elastics or elastic threads are engaged from the distally

bent tail of canine to the inter-maxillary circle on both sides. The elastic thread should be replaced and should be more actively tied at every sitting. This would close the anterior spaces. This method was developed by Kesling. Class II inter-maxillary elastics can be placed and towards the end of first stage, the anterior spaces would close. Bite would be corrected and the pro-cumbency of anterior teeth would be reduced as a result of lingual tipping of their crowns.

Stage II and III

Heavier 0.018 wire should replace the previous wire. Horizontal elastics and inter-maxillary elastics should be used on both the sides for closure of buccal spaces and retraction of the anterior segment. Towards the end, up-righting springs should be placed on the incisors and buccal teeth, if required.

EDGEWISE APPLIANCES

A 2×4 appliance or full mouth appliance could be used as per the case.

Step 1 : Initial alignment of incisors can be done using a flexible braided steel wire or 16 mil Nite.

Step 2 : Stiffer arch wire (16 $\times$ 22 mil stainless steel) can be engaged after the alignment is over.

Step 3 : Sliding mechanics should be used instead of loop mechanics. Forces used to move the incisors reciprocally towards each other can be provided by:

- a. closed coil spring passed through the arch wire and stretched between the two central incisors.
- b. elastomeric chain tying the incisors together; this can be used to close spaces between all anterior teeth. Short chain or long chain elastomers can be used depending on the distance between the two adjacent brackets and the stretch required for activated elastic chain.
- c. open coil springs, which can be passed through the arch wire and can be compressed between the first molar and lateral incisors in a 2×4 appliance.

If the anterior spacing is a result of a tooth size discrepancy (small teeth, large arch), then it is not possible to close all the spaces anteriorly while maintaining the posterior inter-cuspal position. In these cases, teeth should be moved into an ideally separated position, redistributing the spaces and the crowns should be enlarged with either composite build up or ceramic castings. Composite buildups joined in the midline or joint ceramic castings can be used as a wonderful form of permanent retention.

DEEP BITE

Deep bite is a condition where excessive overbite exists. Here, the vertical measurement between the maxillary and mandibular incisal margins is excessive when the mandible is brought into centric occlusion. Deep bite is one of the most detrimental relationships considering the health and longevity of the dental units.

The correction of deep bite is exceedingly important to the welfare of teeth and their supporting structures.

Satisfactory treatment of deep bite requires approximation to the normal overbite along with the elimination of causative factors. Hence, one should determine the etiological differentiation of deep bite. According to the etiology of deep bite, it may be differentiated into *developmental deep bite* and *acquired deep bite*.

1. Developmental deep bite or genetically determined deep bite
This is usually a skeletal deep bite with the following characters:
 - a. Horizontal growth pattern is indicated by lesser gonial angle.
 - b. Anterior lower facial height is small with a long posterior facial height.
 - c. Inter-occlusal clearance is usually small.
2. Acquired deep bite is, generally, of dental origin, which may arise as a result of the following causative factors:
 - a. Lateral tongue thrust can produce an intra-occlusion of the posterior teeth, which, in turn, leads to deep bite. In such cases, freeway space is large, which is favorable for functional appliance treatment.
 - b. Premature loss of deciduous molars or early loss of permanent teeth can cause an acquired deep bite, especially if the adjacent teeth are tipped into the extraction sites.
 - c. Attrition of the occlusal surfaces of the posterior teeth can produce an acquired deep bite.

Thus, acquired deep bite is usually dental deep bite or *dento-alveolar* deep bite with the following characters:

- i. Growth pattern is average or may tend towards vertical growth.
- ii. The problem lies mainly in the dentition, which is either infra-occlusion of molars or supra-eruption of incisors or a combination of both.

Infra-occlusion of molars shows the following features:

- Molars are partially erupted
- Inter-occlusal gap is large
- Lateral tongue posture and thrust are present
- Distance between the maxillary planes, mandibular planes and occlusal planes is short.

Supra-eruption of Incisors shows the following features:

- Incisal margins extend beyond the functional occlusal plane
- The molars are fully erupted
- The curve of SPEE is excessive
- Inter-occlusal space is small.

Deep bite may present itself with or without associated malocclusion. Determining the factors contributing to deep bite is the most important step in planning its treatment. Deep bite should not be viewed as an isolated entity; it must be seen as a part of the total malocclusion. Normally, in a CI-I malocclusion, deep bite is controlled by the dental factors whereas in a CI-II malocclusion, a skeletal morphology dominates the dental factors. Thus, it is more important to correct and retain a CI-II malocclusion than a CI-I malocclusion.

TREATMENT PLAN FOR DEEP BITE

The most important factor in the treatment of deep bite is to decide whether its correction requires *intrusion* of maxillary and mandibular incisors or *extrusion* of posterior teeth or a combination of both. Five basic considerations are necessary for the correction of deep bite to obtain functionally and esthetically stable results. These are:

Consideration of Lip Relation

In relaxed mandibular position, there is, normally, an inter-labial gap of 2-4 mm. Therefore, if a case of deep bite presents itself with excessive inter-labial gap, the *posterior extrusive mechanics* may deteriorate the esthetics. But in the case with no inter-labial gap or *redundant lips*, posterior extrusive mechanics would be helpful.

The incisor-stomion distance is normally 2-4 mm. In a deep bite with normal incisor stomion distance, correction of deep bite by *maxillary incisor intrusion* is not indicated as it will give an edentulous look. In the opposite situation when the incisor-stomion distance is large associated with the gummy smiles, *upper incisor intrusion* would be the treatment of choice. In a case where the incisor-stomion distance is normal, and the mandibular incisors are seen with the lip in a relaxed position, treatment of choice would be *intrusion of lower incisors*. Thus, the line of treatment should be based on all these important factors, which would influence esthetics.

Vertical Facial Relationship

The extrusion and intrusion mechanics influence the vertical facial height. This, in turn, may affect the antero-posterior relationship of the maxilla

and mandible. The extrusion of the posterior teeth brings about downward and backward rotation of the mandible. This increases anterior vertical facial height and also increases the mid facial convexity and thus reduces the anterior deep bite.

Extrusion of posterior teeth should be done judiciously in a patient with long vertical facial height. This can be used effectively in patients with average growth pattern. Thus, a balance between the beneficial and deleterious effects of these factors must be reached.

Consideration of Occlusal Plane

The orthodontic treatment should provide the patient with a flat occlusal plane. Many times, due to lip and vertical height consideration, the correction of deep bite ends up in a step type of occlusal plane between the anterior and posterior region. Thus, overbite and occlusal plane changes should be kept in mind when planning the treatment of deep bite. Studies show that it is difficult to hold deep bite correction in low angle cases, whereas in high angle cases, it is easy to correct and hold the corrected overbite.

Inter-occlusal Gap or Freeway Space

Normally, the freeway space is 2-4 mm. Correction of deep bite should not be done by supra-erupting the posterior teeth into this space as this will, most often, tend to relapse due to the forces of the muscles of mastication. Moreover, there will be full occlusal contact of the posterior teeth during speech and mastication and this will result in pathological changes in the tempero-mandibular joint.

The amount of freeway space is an important factor in the prognosis of a deep bite correction because, when freeway space is large, greater opportunities exist for correction by guiding the vertical alveolar development. A proper cephalometric analysis and determination of freeway space are also necessary for proper treatment plan.

Patient's Age and Length of Treatment

In adult patients having deep bite with vertical facial and alveolar problems, it is better to suggest orthognathic correction as only orthodontic treatment would be very long and insufficient for complete correction.

TREATMENT OR MANAGEMENT OF DEEP BITE

For the disease of malocclusion, there is only one medicine and that is force. There are a number ways to apply that force. There are five basic phenomena to treat deep bite. These are:

1. Levelling the arch through the *eruption of premolars* associated with clockwise rotation of the mandible and increase in the lower facial height.

2. Extrusion of molars.
3. Intrusion of upper and lower incisors.
4. Labial inclination of the incisors.
5. Extrusion of molars with inhibition of further eruption of incisors. The maxillary molar is the primary bite opener.

Therefore, depending on the factors such as:

- Age
- Growth pattern
- Etiology of deep bite
- Requirements of the particular case,

Deep bite can be corrected by:

1. Removable appliance therapy.
2. Myofunctional appliance therapy.
3. Fixed myofunctional appliances like Herbst appliance and Jasper jumper.
4. Combination of removable appliances with extra-oral forces; ACCO of Margolis (acrylic cervico-occipital anchorage appliance).
5. Fixed appliance therapy.
6. Fixed appliances along with vertical pull headgear.
7. Orthognathic surgery.

REMOVABLE APPLIANCE THERAPY

When the deep bite is associated with decreased lower facial height and low FMA for growing children, removable appliances are the right choice:

Anterior Bite Plane

It is a removable appliance, which is made up of a bite plane or a platform behind the upper incisors on which the lower incisors bite. The plane is parallel to the occlusal plane. A labial bow of heavy arch wire is included in the appliance to prevent the anterior inclination of upper incisors due to the anterior component of force. The anterior bite plane depresses the anterior teeth and the relieved posterior teeth erupt further. This effect is called as opening the bite (Fig. 12.1).

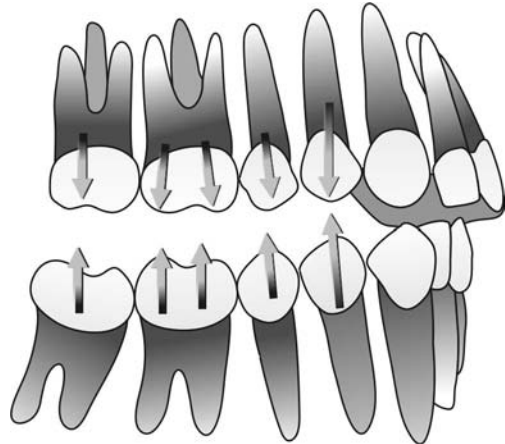


Fig.12.1: Schematic view of deep bite correction with anterior bite platform

SVED Bite Plane

In 1944, Sved introduced a bite plane named after him, which covered the incisal edges of the upper anterior teeth, thus transmitting the pressure axially to the teeth and eliminating the anterior component (Fig.12.2). After allowing the required overbite correction, the appliance should be worn as retention and should not be discontinued suddenly.



Fig.12.2: SVED type of anterior bite platform with incisal capping to prevent their supra-eruption and labial flaring

Expansion and Labial Segment Alignment Appliance with Bite Plane (ELSAA)

In some cases of CI-II div 2 in actively growing patients, this appliance may be used before starting myofunctional therapy. This appliance achieves anterior arch alignment prior to the functional therapy in the following way:

1. By expanding the upper labial segment by 4-5 mm with the activation of an expansion screw.
2. By utilizing this expansion to roust out the upper labial segment.
3. By the incisor function in the anterior bite plane, the upper incisors are tipped labially, thus increasing the overall arch perimeter.
4. By opening the bite anteriorly along with slight intrusion and slight protrusion of upper and lower labial segments.

MYOFUNCTIONAL APPLIANCE THERAPY

Myofunctional appliances use the muscular forces that are generated by altering the mandibular position sagittally and vertically to bring about the required orthodontic and orthopedic changes.

Activators in the Management of Deep Bite: Principle

The activator corrects the deep bite by the principle of differential eruption. The activator simulates active intrusion of the incisors by inhibiting their normal eruption since the teeth in the buccal segments are allowed to follow their normal eruption paths and the incisors are not allowed to erupt. The effect of intrusion is achieved without actively intruding the incisors.

Case Selection for Activator Therapy

Activator treatment increases the lower facial height in those patients who have a vertical growth component. Thus, patients with excess lower facial height should not be opted for activator treatment. Growing patients who have excess freeway space and reduced lower facial height resulting from mandibular over closure are good cases to be selected for activator treatment.

Construction Bite

The construction bite should induce the following effects in the fabricated appliance

- To bring the mandible into a tolerable anterior position with every occluding action of the mandible.
- To 'block the bite' depressing the lower anterior teeth and inhibiting their eruption while allowing and harnessing the eruption of the posterior teeth.

The true midlines of the jaws must coincide when the construction bite is taken. In most individuals, inter-occlusal clearance is 2-3 mm in the molar area and 4-5 mm in the incisor area. So, a construction bite with an opening of 4-5 mm in the molar area and 6-7 mm in the incisor area would be required.

- In true CI-II div 2 cases of deep bite, construction bite can be opened upto 9 mm in the incisor area in permanent dentition.
- In CI-II div 1 case with deep bite, the amount of bite opening will depend on the amount of anterior positioning of the mandible required to establish a normal positioning. The thumb rule is:
 - Large bite opening for larger anterior positioning.
 - Large bite opening in cases of deep bite with more vertical growth.
 - Small bite opening for smaller anterior positioning.
 - Small bite opening in cases of deep bite with more horizontal growth.

Management of the Appliance

The patient is demonstrated to insert the appliance in the mouth and remove the appliance from the mouth.

- *First week wear:* 2-3 hours during the day.
- *Second week wear:* 2-3 hours in the day; 8-9 hours at night during sleep.
- *Third week:* Evaluate for trimming.

If there is no difficulty in the appliance wear, check-up appointments are fixed at every 6-week interval.

Trimming of the Activator

The gingival halves of the dental embrasures in the processed acrylic must be maintained for vertical movements of posterior teeth. All other parts of the embrasure that could prevent the vertical movement of the eruption of the teeth are removed.

Honey-comb Appearance

In the maxillary buccal segment—Acrylic on the disto-palatal surface must be reduced to stimulate distal tipping.

In the mandibular posterior segment—Acrylic on the mesio-lingual surface must be reduced to allow mesial movement.

Modifications of the activator can be used e.g. *Herren Shaye modification* and *palate-free activator of Metzelder*.

FUNCTION REGULATOR OF FRANKEL IN THE MANAGEMENT OF DEEP BITE

Principle

The functional regulator corrects the deep bite by stimulating normal function while eliminating the lip trap, hyperactive mentalis, aberrant buccinator and orbicularis oris action. The basic difference between the FR and activator is that the FR is confined to the vestibule of the oral cavity unlike the activator. It holds away the buccal and labial segments from the dentition in those areas where this pressure has restricted the development of these areas during the critical transitional phase of development.

Deep bite is corrected by the differential eruption of the posterior teeth into the space created by the bite. Buccal soft tissue inter-positioning in this space is prevented by the buccal shields.

Case Selection for Functional Regulator Therapy

This appliance is a universal appliance and can be used to treat all the conditions of malocclusion with its basic variations discussed below.

- i. *FR-I*: for correction of Class-I and Class-II, div 1 malocclusion.
- ii. *FR-II*: for correction of Class-II, div 1 and div 2 malocclusion.

For deep bite correction, FR-I and FR-II can be used. Best effect can be achieved with patients in the *late mixed dentition* and *transitional dentition* period when both soft and hard tissues are undergoing their greatest transitional changes.

Construction Bite

Frankel has been strongest advocate of small mandibular advancements and minimal vertical separation of the jaws. Initial mandibular advancement is, in general, up to 4-6 mm whereas initial vertical opening is about 3-4 mm. This amount of space is necessary for the connectors between the facial and lingual components. Midline discrepancy should not be corrected in bite by manipulation during forward posturing.

Management of the Appliance

The patient is demonstrated to place and remove the appliance from the mouth.

First week wear: 3-4 hours during the day.

Second week wear: The appliance does not produce much interference with speech. Thus, a full time wear, not just nighttime wear, is recommended. Daily functional exercise is also recommended for the success of Frankel appliance. (The reader is reminded to go through with all the appliance designs by referring to other text sources).

TWIN BLOCK IN THE MANAGEMENT OF DEEP BITE

Principle

The appliance mechanism is designed to harness the forces of occlusion to correct the distal occlusion and the overbite. The main difference between the other functional appliances and the Twin block is that these are made in one piece to fit the teeth in both jaws, while the Twin block is made in 2 blocks (upper and lower). The patients wearing other functional appliances could not speak or eat with the appliance in the mouth. But with Twin blocks, patients can function normally and are able to eat and speak without restriction of movements of tongue, lips and mandible.

Case Selection for Twin Block Therapy

Actively growing patients with a large over jet (10-12 mm) and a deep bite are the ideal cases to be opted for Twin block therapy. These are mainly Angel's CI-II div 1 malocclusion with a full unit distal occlusion in the buccal segments and a good uncrowded arch form.

Construction Bite

Project bite-gauge is designed to record a protrusive bite for construction of twin blocks. It registers 2 mm bite clearance between the incisal edges of the upper and lower incisors in the cases of deep bite. A protrusive bite is registered to reduce the over jet on an average 5-10 mm. In a growing patient, bite may be achieved up to edge-to-edge on the incisors with 2 mm inter-incisal clearance.

Management of Appliance

The patient is demonstrated to insert the Twin blocks in the mouth. It is essential to encourage the patient to keep the appliance in the mouth at all times except for cleaning and contact sports. It is important to explain to the patient to learn to eat with the appliance in the mouth as the force of biting on the appliance corrects the jaw position.

FIXED MYOFUNCTIONAL APPLIANCE THERAPY

These are functional appliances that eliminate the need of patient compliance in wearing the appliances. Most of them apply forces using auxiliaries and springs between the arches. Commonly used fixed functional appliances for deep bite correction are *Herbst appliance* and *Jasper jumper*.

Herbst Appliance

Principle

Herbst appliance displaces the condyle anteriorly at all times but the amount of force against the teeth is very much under the patient's control. Pressure

against the teeth can produce significant tooth movement in addition to any skeletal effects. It consists of a bilateral telescopic mechanism that maintains the mandible in the protruded position (Fig. 12.3). The Herbst can be banded (dentaurum) or splinted by acrylic splint Herbst appliance. Jaw position is controlled by a pin-and-tube device, that runs between the arches.



Fig.12.3: Herbst appliance with screw mechanism to open the bite (Courtesy: ORMO)

Case Selection for Herbst Therapy

Deep bite cases with skeletal or dental Class-II malocclusions and with retroclined mandibular incisors are the right indications for Herbst therapy. Patients with excess lower facial height and cases prone to root resorption should not be selected for this appliance therapy.

Impression and Construction Bite

Bands are fitted over the desired teeth. Impressions are taken with the bands in place and then poured into casts. Most clinicians now prefer metal crowns over bands for retention of fixed functional appliances; working bite is similar to the one for activator appliance.

Management of the Appliance

The maxillary and mandibular splints are cemented or bonded to the teeth. The upper and lower splints are joined by a pin-and-tube apparatus. After a few months, increments of advancement can be produced readily by adding spacers to the sliding pin-and-tube assembly.

Jasper Jumper

It consists of two auxiliary springs, which are fitted to fully banded upper and lower fixed appliances. These springs are attached to the maxillary first molars posteriorly and the mandibular archwire anteriorly. These springs rest in the buccal sulcus and hold the mandible in protruded position.

Case Selection for Jasper Jumper Therapy

Deep bite cases in dental Class-II malocclusion with retroclined mandibular incisors are indicated for this. Patients with open bites, vertical growth pattern and those prone to root resorption should not be chosen for this treatment.

COMBINATION OF REMOVABLE APPLIANCE WITH EXTRA-ORAL FORCES

Mainly the ACCO (Acrylic Cervical Occipital Anchorage) appliance developed by *Margolis* is used for deep bite correction. This is a removable

acrylic appliance, which is used in conjunction with a headgear for reception of orthopedic force. ACCO consists of an outer labial bow from 21—|—¹². Acrylic is added over the labial wire. It reduces the tipping action that may occur because of the reception of extra-oral force arms in the anterior region.

- 0.040 tubes are soldered vertically between upper lateral and central incisors instead of bending loops in the labial wire for reception of headgear.
- An inclined plane is added for all possible forward growth and elimination of mandibular functional retrusion (Fig. 12.4). This stimulates eruption of lower posterior teeth and levels the curve of SPEE.
- Finger springs are added for distal movement of posterior teeth.
- This appliance is used for distalization of the upper buccal segment and allows unrestrained mandibular growth.
- ACCO can be worn for 24 hours a day and with headgear wear for 12 hours a day.

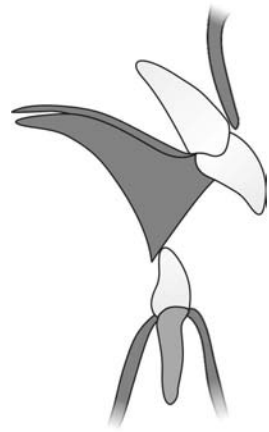


Fig.12.4: Inclined plane to stimulate eruption of lower posterior teeth and allow possible forward growth of the mandible

FIXED APPLIANCE THERAPY

There is an excellent deep bite correction with the Begg's appliance and combination of Begg and Edgewise appliances. The anchor bends in initial arch wire along with use of CI-II elastics together achieve the correction. 0.016 Australian wire or steel arch wire with anchor bends placed mesial to the first molar is pinned in all tooth brackets but is ligated lightly as it passes the second premolar bracket. The long span of the arch wire anterior to the anchor bend provides a gentle intrusive force on the incisors, while the reaction force on the molar tends to upright it and tip it distally. Light CI-II elastics are used with arch wire in place. CI-II elastics of 2-2.5 oz force levels are used and are worn around the buccal tube of the lower molar to the upper inter-maxillary circle mesial to the upper canines.

The result of CI-II elastic is stabilization of the lower molar against the distal tipping at the cost of some extrusion of the molar. The light arch wire intrudes the lower incisors in similar way, but the upper incisor intrusion is slightly counterbalanced by the downward pull of Class-II elastic.

The Edgewise appliances achieve deepbite correction in two ways:

Leveling by Extrusion (Relative Intrusion)

This is achieved with continuous arch wires having exaggerated curve of SPEE in the maxillary arch wire and reverse curve of SPEE in the mandibular

arch wire. After the initial alignment phase, the second arch wire for leveling should be either 16 mil steel or 18 mil Ni-ti wire.

- *Upper arch:* 16 mil steel for 18 slot bracket, with exaggerated curve of SPEE placed in the upper arch wire or 16 Ni-ti or 18 mil M-Ni-ti performed by manufacturer with an exaggerated curve of SPEE.
- *Lower arch:* 16 mil steel with reverse curve of SPEE placed in the lower arch wire or 16 mil Ni-ti or 18 mil M-Ni-ti preformed by the manufacturer with an exaggerated curve of SPEE.

Sometimes with a 22 slot wider bracket, stiffer wire like 20 mil steel wire may be required after possible leveling has been achieved by 18 mil wire. Sometimes, auxiliary leveling arch is used when heavier wires are required to complete the leveling of arches:

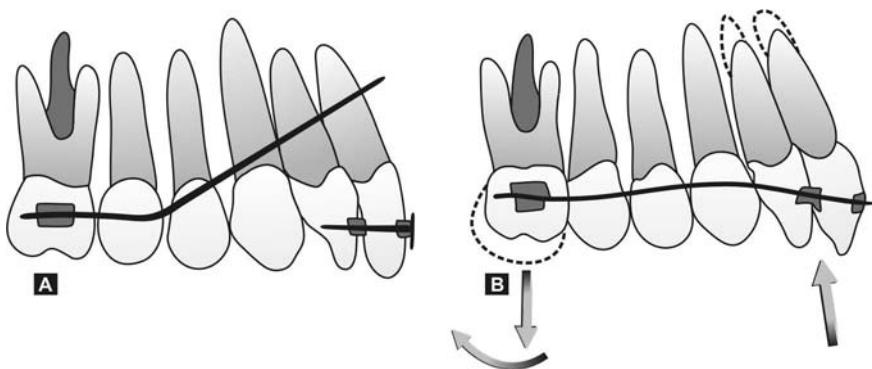
- *Base arch wire:* 16 mil steel
- *Auxiliary leveling arch:* 17 × 25 mil TMA or steel.

The auxiliary arch is inserted into the auxiliary tube on the molar and is tied anteriorly beneath the 16 mil base arch. Although, the auxiliary wire gives the appearance of intrusion arch, leveling occurs almost by extrusion as long as a continuous rather than segmental wire is in the bracket slots.

Leveling by Intrusion

The key to intrusion is light continuous force directed towards the apex of the tooth. Intrusion of one tooth should not be pitted against the extrusion of adjacent teeth, because in this case, extrusion would dominate. This can be accomplished in two ways:

- Bypass arches – continuous wires that bypass pre-molars and frequently canines.
- Segmented arch wires for leveling (developed by Burstone)—segmented approach in which posterior segment is stabilized and anterior segment is controlled for force application.
- Bypass arches (Mulligan's leveling arch)—16 mil steel wire with anchor bend, which is inserted in the molar tubes, bypasses the pre-molar and sometimes canines and is engaged in anterior teeth (Fig.12.5A and B).



Figs12.5: A. Schematic representation of a passive intrusion arch for correction of deep bite; B. Schematic view of force mechanisms of an activated intrusion arch

- Ricket's utility arch—16 × 16 mil wire with step-down bends between the first molar and the lateral incisor used in 18 slots brackets.
- Segment approach: After initial alignment, a rectangular wire 17 × 25 steel is placed in the bracket slots of second molar, first molar and second pre-molar, which connects these teeth into a stable unit. Lingual arch may be used between the right and left posterior segments for further stabilization. A resilient wire is placed in the anterior segment. The rectangular depressing arch wire is tied beneath this resilient wire anteriorly.

FIXED APPLIANCES ALONG WITH VERTICAL PULL HEADGEAR

Usually, with the use of bypass arches, only the molars are available as posterior anchorage. Thus, significant extrusion of the tooth may occur. In actively growing patients with an average facial pattern, this is acceptable. But in non-growing patients with a poor skeletal pattern, excessive molar eruption should be avoided. Lack of posterior anchorage comprises the ability to intrude incisors.

- High pull headgear to the upper molar can be added along with any bypass arch systems to improve upper posterior anchorage.
- High pull or vertical pull headgear: Force is applied to the maxillary anterior segment through the hooks attached between lateral incisors and canine in the upper inner arch wire of face bow. This is used to depress the maxillary incisors and moves the roots of the maxillary incisors lingually. It is used in the augmentation with C1-II inter-maxillary elastics.

ORTHOGNATHIC SURGERY

Resection and osteotomy is done to correct skeletal deep bite in the adult patients. Lower labial set down is indicated. For detailed discussion on the topic, the reader should refer to chapter on Surgical Orthodontics.

DEFINITION

Open bite is a condition where a space exists between the occlusal or incisal surfaces of maxillary and mandibular teeth in the buccal or anterior segments when the mandible is brought into centric occlusion. Alternatively, open bite is defined as the failure of the occluding surfaces of teeth to achieve contact when the teeth are brought into full closure. When a case of open bite presents, it is important to first classify the open bite to plan its management.

Open bite can be classified as:

- *Anterior open bite*: failure of incisor teeth to overlap.
- *Posterior open bite*: failure of posterior teeth to occlude unilaterally or bilaterally. Also, open bite can be classified as:

Inherited Open Bite

This open bite is due to inherited growth pattern or abnormally large sized tongue.

- Genetically determined or skeletal open bite
- There is normal eruption of anterior teeth along with the downward and backward rotation of the mandible with excessive eruption of posterior teeth
- Short ramus
- Increased gonial angle
- Narrow maxillary arch is possible
- Long face pattern or skeletal open bite with vertical growth pattern.

Acquired Open Bite or Dental, Dentoalveolar Open Bite

Posterior teeth usually erupt to a normal amount but the anterior teeth do not occlude due to environmental factors that affect occlusion. These abnormal environmental factors, which keep the patient's mouth open are:

- Lateral tongue posture and anterior tongue thrust
- *Prolonged digit sucking*: This may affect the alveolar bone and move the teeth out of occlusion
- *Mouth breathing*: The postural changes dictated by partial nasal obstruction may play a role in causing open bite
- Inter-positioning of the lower lip between the dental arches i.e. lower lip trap.

APPROACH TO OPEN BITE CORRECTION

- The management of open bite should be directed primarily to eliminate the causative factors.
- The curve of occlusion of mandibular teeth should be corrected and the maxillary teeth should be brought into vertical alignment.

MANAGEMENT OF ANTERIOR OPEN BITE

1. Elimination of the abnormal habits like digit sucking and tongue thrusting

- *Correction of digit sucking habit*
 - Motivation: If the habit is first noticed at the time of eruption, the simplest approach is a clear discussion between the child and the dentist that expresses concern and explanation of the effects if this habit is continued. Audiovisual aids can be used to explain to the child that he would develop protruded teeth if he continues with the habit. A reward system can be implemented that provides a small reward daily for not engaging in the habit. This is the 'adult motivational approach' and sometimes, this is enough to terminate the habit in well perceptive patient.
 - Habit breaking measures and appliances: Any habit breaking appliance or measure is used because
 - It makes it very difficult for the child to place the thumb or any digit in the mouth.
 - It breaks the suction and hence, the child derives no satisfaction from the habit.
 - It prevents abnormal digit pressure on the maxillary incisors and hence, prevents them from being displaced further labially and creating more open bite.
 - It forces the tongue backward exerting more pressure on the maxillary buccal segments and the narrowing of the maxillary arch by abnormal swallowing habit is reversed.

The appliances should be presented to the child as an aid and not as a punishment. These appliances could be removable appliances or fixed appliances:

- a. Simple removable acrylic plate with tongue spikes.
- b. Removable appliance with tongue guard.
- c. Oral screen.
- d. Fixed maxillary lingual arch with an anterior crib.
- e. Rakes.

In most of the children for whom one of these appliances is made, thumb sucking stops immediately and the open bite begins to close rapidly. In rest of the children, thumb sucking persists for a few weeks and eventually gets eliminated. It is a good practice to leave these appliances in place for 3-6 months after the habit gets dropped.

- *Other habit breaking measures:* These measures remind the child that the digit or thumb is in the mouth but these measures, definitely, remove the pleasure of sucking. This approach would be helpful in a passive sucker who engages in this habit during sleep, reading or watching television.

These measures are:

- i. Apply bandage or socks to the thumb.
- ii. Apply a non-palatable or bitter substance to the thumb.
- iii. Apply an adhesive tape to the thumb. When he feels the tape in the mouth, it reminds the child to stop.

Correction of Tongue Thrusting Habit

One or more of the following approaches should be used:

- i. Myotherapeutic exercises for the tongue.
- ii. Removable acrylic plate with anterior tongue spikes or tongue guard as a habit breaking appliance.
- iii. Fixed maxillary lingual arch with anterior spikes as a habit breaking appliance.

2. Correction of mouth breathing or any nasal obstruction that causes postural changes

- Eliminate the underlying pathology like obstructive adenoids, allergic reaction to nasal mucosa, inflammatory and oedematous reaction of nasal mucosa, etc.
- Use appliance like oral screen as a corrective aid or taping of the lips.

Oral screen is a multipurpose functional appliance, which can correct habits like mouth breathing, thumb sucking, lip biting and tongue thrusting and hence, can be used to correct mild disto-occlusions with maxillary protrusion and open bite in deciduous and mixed dentition.

Principle: It acts like a mechanical barrier for practicing any of the habits and makes it impossible to practice the habit. It prevents the peri-oral muscle forces and counter forces of tongue to act on the alveolus and teeth. This, not only breaks the habit, but also results in the lateral expansion of the arches.

Also, flaccid, hypotonic muscles are induced to work as it is also used as a myofunctional exerciser. When the patient closes the lips or swallows, the muscle forces are transmitted to the anterior teeth, which retract the anterior teeth and close the bite.

For correction of mouth breathing, an oral screen with breathing holes can be used to initially prevent breathing difficulties. Also, a metal ring can be embedded anteriorly so that the oral screen can be used as a muscle exerciser.

3. Correction of Lower Lip Trap

When the lower lip is sucked or habitually trapped into the oral cavity and behind the upper anteriors, it inhibits the eruption of lower incisors and displaces the upper anterior teeth labially along with an intrusive component. This habit can be corrected by using a lip bumper appliance, which keeps the lower lip away from the lower incisors and prevents it from cushioning to the lingual of the maxillary incisors during rest and function.

This is usually made for the lower arch and could be of removable or fixed type. It generally has a labial plastic sleeve or acrylic cover in the anterior region and connects distally into the mandibular molars.

4. Myofunctional Appliances

These appliances mainly create a headgear effect to control the vertical facial growth and close the anterior open bites.

Modified Activator

The activator is not indicated for the treatment of skeletal open bite but for the open bite, which is caused by abnormal oral habits.

- It is used mainly as a habit breaking appliance in the cases of open bites associated with tongue thrust and finger sucking. The tongue cannot rest over the incisal edges of the teeth and this confinement of tongue is helpful in correction of tongue thrust.
- The activator is constructed so that the primary effect is to inhibit the eruption of posterior teeth and encourage the eruption of anterior teeth.
- Regardless of whether the mandible is advanced forward in the construction bite, the bite must be opened past the normal resting vertical dimension if the molar eruption is to be affected. When the mandible is held in this position by the activator, the stretch reflex of the oral musculature exerts a vertical intrusive force on the posterior teeth. Acrylic is not ground away from the occlusal surfaces of posterior teeth but the anterior teeth are allowed to erupt.

This reduces the open bite. Appliance wear of 12-14 hours per day will tend to close the open bite in a few well selected cases.

Bionator in the Management of Open Bite

Bionator was developed by *Balters* keeping the following philosophy in mind:

"The equilibrium between the tongue and the circumoral muscles is responsible for the shape of the dental arches and the inter-cuspation. The functional space for the tongue is essential for the normal development of the oro-facial system".

When the bionator is used as an open bite bionator, it is constructed so as to inhibit the abnormal posture and function of the tongue and to prevent the extrusion of posterior teeth.

Open bite bionator: It varies from standard bionator in the following way. The working bite is kept as low as possible with acrylic bite blocks between the posterior teeth to prevent their extrusion. The acrylic portion of the lower lingual area extends behind and lingual to the anterior teeth. This acts as a lingual shield, which restricts the resting tongue, thumb, finger and other foreign objects from the position between the teeth. As the acrylic lingual shield is placed behind the anterior teeth, it leaves the anterior teeth free to erupt while the posterior teeth are blocked. 'Buccinator bow of wire' or a plastic shield would hold the soft tissue away from the teeth and disrupt the tongue—cheek equilibrium, which in turn, would lead to buccal movement of teeth and arch expansion.

A fulltime, mainly nighttime wear would be recommended for closing the bite.

Frankel Appliance (FR-IV)

This is used for correction of open bite. This appliance makes the oral vestibule as the operational basis and relieves the adverse pressures on the teeth from the lips and cheeks. Hence, the jaws and lips can be induced to grow and the teeth can be moved into more favorable positions. It intercepts the aberrant muscle function and eliminates the weak and flaccid peri-oral musculature. FR-IV is used for the correction of open bites and its use is exclusively confined to the mixed dentition period.

The main feature in FR-IV is the inclusion of posterior bite blocks, which would inhibit the eruption of posterior teeth and the anterior teeth are allowed to erupt. This type of appliance treatment is effective in controlling vertical facial growth and closing anterior open bite.

5. Orthopedic appliances for correction of skeletal anterior open bite (headgear with chin cup)

In the case of skeletal open bite, corrective efforts with tooth-borne appliances are usually inadequate as over-eruption of incisors produces no change in the mandibular morphology and the inter-occlusal space also does not increase. Therefore, orthopedic appliances should be used to bring about the basal change within the bone system for stable and lasting open bite correction (Figs 13.1A and B).

Appliances

In skeletal Class III malocclusion with open bite, the conventional vertical pull head cap is used as a base of anchorage and chin cap, which extends posteriorly along the inferior border of the mandible, is used along with it. It may be made by taking an impression of the chin area and fabricating the appliance in acrylic or a soft flexible pre-fabricated chin cup can be used with vertical pull headgear. The vertical pull is used to prevent the mandible from going downwards. Hooks are embedded in the chin cup to

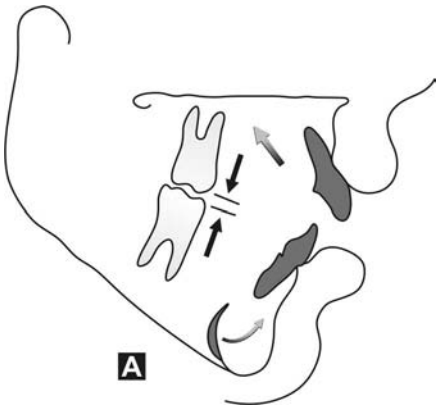


Fig.13.1A: Schematic representation of the treatment approach for patients of open bite with excessive lower facial height. Appliance therapy as shown by diagrammatic representation is to restrict posterior eruption and control the descent of maxilla

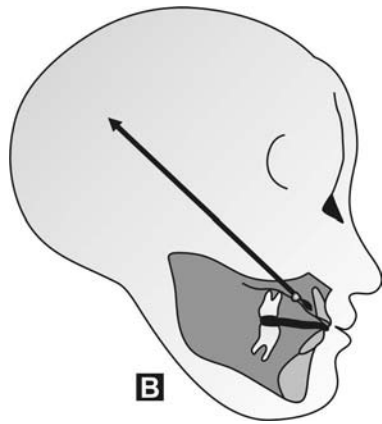


Fig.13.1B: Schematic view of the force system of a high pull headgear to a short face bow inserted in the maxilla

allow the attachment of controlled coil spring traction. A palatal appliance is often placed with an occlusal extension; since there is no inter-occlusal clearance, a stretch reflex is elicited, which augments the vertical depressive appliance forces. If the maxillary arch is narrow, a jackscrew can be added in the removable appliance for slow expansion. When removable appliance is discontinued, a ready made inter-occlusal clearance would exist.

Timing of treatment: The best time to use chin cup with a vertical pull headgear is the late deciduous dentition phase or early mixed dentition phase.

Length of appliance wear: 12-15 hours per day.

Magnitude of force: This should start from 6-12 ounces on each side reaching a level of 2-3 pounds. The objective is to have a basal effect with the added objective of preventing eruption of posterior teeth.

6. Intra-oral fixed appliances

Open bite problems usually have a tooth system involvement in addition to the basal mal-relationship. When the anterior open bite is dentoalveolar in nature, then a full fixed appliance can be indicated in permanent dentition. But when there is a basal mal-relationship along with dentoalveolar open bite, it is advisable to use a combination of fixed appliances and basal orthopedic force. Both the Begg's appliance or the Edgewise appliance can be used equally effectively with almost the same wire requirements.

After initial alignment with light wires, an individual extrusion arch could be designed for extruding anterior teeth and intruding or holding

posterior teeth. Intruding posterior teeth permits counter-clockwise rotation of mandible. Extrusion of anterior teeth is a dental compensation for this condition and can be achieved by two means:

- i. Extrusion arches
- ii. Vertical elastics or box elastics

Extrusion arches are simply intrusion arches with all their force systems inverted.

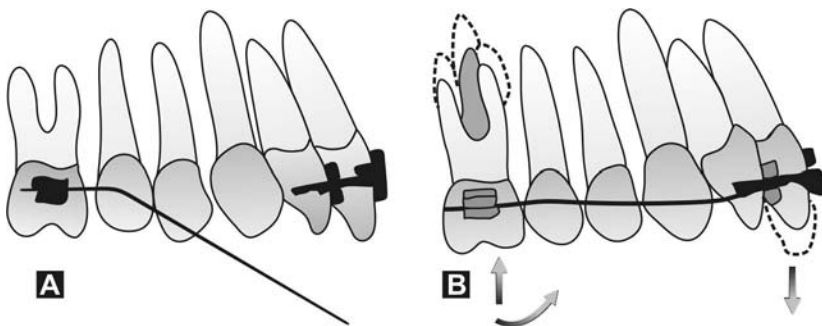
The extrusion arch generates forces that are extrusive at incisors and intrusive on molars (Figs 13.2A and B). Extrusion occurs quite rapidly and hence, treatment must always be carefully monitored.

In the Begg appliance, a typical arch wire for closing open bite is formed, using in conjunction with anterior vertical or box elastics. The amount of anchor bend should be reduced from 45° to 25° and extrusive bend should be placed 2 mm distal to the canine brackets on both the sides. This is sometimes referred as 'arch wire with reduced anchor bends and canine kinks'. This wire when engaged in the appliance along with vertical elastics brings about the dental compensation. Class II elastics should be used judiciously. Open bite should be over-corrected to slightly deep bite so that with minor relapse, the bite settles to a normal overbite over a period of time.

Vertical elastics or box elastics: These inter-arch elastics can be used in the permanent dentition phase along with full fixed orthodontic appliances in the treatment of mild open bite cases. Inter-arch anterior box elastics pit upper anterior teeth and lower anterior teeth against each other and cause differential extrusion of anterior teeth. This can be followed by interlacing vertical elastics between upper and lower anterior teeth.

7. Fixed orthodontic appliances in combination with extra-oral appliances

For moderate open bite cases, corrective efforts with tooth-borne fixed appliance and vertical elastics may be inadequate as stimulating over-



Figs 13.2: A. Schematic view of a passive extrusion arch for correction of anterior open bite; B. Force mechanism of an activated extrusion arch

eruption of incisors produces little change in the molar area and does not increase the inter-occlusal space, which is very important. Hence, orthopedic appliances that bring about a basal change within the bone system, should also be included in the appliance therapy for stable open bite correction. Thus, a combination of full fixed orthodontic appliances with basal orthopedic forces can be used in permanent dentition moderate open bite cases.

8. Orthognathic surgery

Young adult patients with severe skeletal open bite can be chosen for this surgery. Usually, LeFort I osteotomy is preferred to reposition the maxilla. For further details, one should refer to the chapter on "Surgical Orthodontics".

TREATMENT OF POSTERIOR OR LATERAL OPEN BITE

This is a rare condition caused by:

- i. Lateral tongue thrust
- ii. Primary failure of eruption of posterior teeth, e.g. submerged or ankylosed posterior teeth.

Treatment

- i. Lateral tongue thrust can be treated by
 - a. use of lateral tongue spikes in removable or fixed appliance
 - b. bionator or FR-IV appliance
- ii. Once the tongue thrust is corrected, vertical or interlacing posterior elastic can be used with full fixed orthodontic appliance in the permanent dentition.
- iii. Full fixed appliances can be used for correction of submerged and ankylosed teeth.

CROSS BITE

Cross bite is defined as a deviation from the normal bucco-lingual relationships of teeth of one arch with those of the opposing arch. Cross bites could be anterior/posterior or unilateral/bilateral.

Cross bites whether anterior or posterior could be accompanied with displacement or could present without displacement.

Displacement might occur when there is a premature or deflecting cuspal contact on closure and the mandible is functionally postured either anteriorly or laterally to achieve better inter-digitation. Repeated practice of this new path of closure makes it a habit and the patient closes straight into this habitual maximum inter-digitation.

Detection of displacements is very essential to determine the line of treatment of cross bites. Follow the procedure given below.

- i. Ask the patient to roll his tongue back to touch the back of the palate and then, close together slowly. Guide the mandible back and try to get the patient to close and occlude on a hinge axis.
- ii. Then, look for clues of displacement like
 - a. Posterior unilateral cross bite.
 - b. Midline shift of the lower dentition in the direction of displacement.
 - c. In the case of anterior displacements, incisors show reverse overjet in centric occlusion (CO). But in the centric relation (CR), incisors touch edge to edge. This antero-posterior difference between CO and CR is the functional displacement.

These occlusal interferences that lead to displacements can be caused by early loss of deciduous teeth, decayed teeth, ectopically erupting teeth. These displacements should be detected and corrected early otherwise these can lead to skeletal cross bites in future.

Etiologically, cross bites can be skeletal or dental in origin.

Antero-posterior discrepancy can contribute to anterior cross bites. Also, they can be a major factor contributing to Class II malocclusion with posterior lingual cross bite and Class III buccal cross bites.

Generally, the skeletal component is a major factor in posterior cross bites. Dental cross bites occur due to various factors that disturb the normal eruptive path of the teeth like anomalies in number, shape and size of the

teeth, prolonged retention of deciduous teeth, delayed eruption of permanent teeth, and presence of supernumerary teeth.

Skeletal cross bites arise due to the etiological reasons like heredity (skeletal Class III), trauma at birth like a forceps delivery causing ankylosis of TMJ, growth retardation due to trauma during growth, accidental trauma after growth completion causing mal-union of the fractured segments, persisting oral habits that were not corrected during growth. After understanding the etiological factors behind the existing cross bites and after learning the detection of displacements, it becomes important to understand the location of cross bites to plan their precise management.

Anterior Cross Bite

Anterior cross bite is a condition where a reverse over-jet is seen i.e. the maxillary incisors occlude posterior to the lingual of mandibular incisors. It could be a single tooth cross bite or a segmental cross bite. Anterior cross bites could be associated with Class I molar relationship (easier to treat) or Class III molar relationship (difficult to treat).

Posterior Cross Bites

Posterior cross bites could be unilateral or bilateral depending on the existence of cross bite on one or both the sides. Again, it could be either a single tooth or a segmental cross bite.

- Buccal cross bite is a condition where the buccal cusps of lower premolars or molars occlude buccally to the buccal cusps of the upper premolars or molars.
- *Lingual cross bite* is a condition where the buccal cusps of the lower molars occlude lingually to the lingual cusps of the upper molars.

One extreme condition of posterior cross bite is where the maxillary palatal cusps are placed buccal to the buccal cusps of mandibular posterior teeth. This is known as *Scissors bite*.

- Posterior cross bites could be associated with any form of molar relationship with CI-I, CI-II or CI-III.
- In the case of unilateral posterior cross bite, always determine for a transverse functional shift before planning the management.
- Bilateral posterior cross bites could result either from maxillary constriction or mandibular expansion or a combination of both.

TREATMENT OF CROSS BITES

Let us consider treatment of cross bites as management of anterior cross bites and management of posterior cross bites.

Management of Anterior Cross Bites

Let us discuss separately anterior cross bites associated with CI-I malocclusion and anterior cross bites associated with CI-III malocclusion.

Factors influencing the correction of anterior cross bites associated with Class I MO:

- i. *Anterior shift from centric relation (CR) to centric occlusion (CO):* The patients who have an anterior shift from CR to CO during mandibular closure, usually have a Class I molar relationship and are considered as pseudo Class III cases. Apart from anterior shift, other features of this functional displacement are:
 - a. Maxillary incisors in cross bite may be more lingually inclined than normal.
 - b. Mandibular incisors in cross bite may be more labially inclined than normal.
 - c. The patient can make some contact of maxillary and mandibular incisal edges in the most retruded position of the mandible.

This functional anterior cross bite (or pseudo Class III conditions with a Class molar relationship) can be treated in a short time with good prognosis and stability.

- ii. *Over bite:* Anterior cross bites with little or no over bite can be treated rapidly but very difficult to retain because the stability of cross bite correction depends on the presence of adequate over bite. These cases should be treated with fixed appliances to extrude the incisors so as to develop an adequate over bite for natural retention.

Anterior cross bites with deep over bites need a placement of posterior bite blocks to allow the lingually locked maxillary incisors to move labially without occlusal interferences from the lower incisors (Fig.14.1).

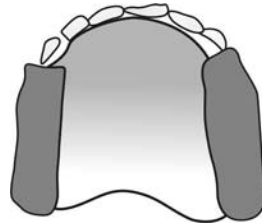


Fig.14.1: Upper removable appliance with posterior bite platform or bite block

- iii. *Anterior available arch length:* There should be presence of adequate space in the arch to allow an appliance to move the tooth in cross bite into proper alignment. In the case of space deficiency, space-regaining procedures should be carried out before activating any appliances for cross bite correction. If the space discrepancy is minor, proximal slicing of adjacent teeth can be done with or without an open coil push spring in the fixed appliance so as to create adequate space for alignment of tooth (or teeth) in cross bite. In severe space discrepancy, therapeutic extractions with complete fixed appliances are necessary.
- iv. *Position of maxillary incisor roots:* Sometimes, the roots of maxillary incisors in cross bite are so far lingually placed that the tooth remains labially inclined when their crowns are moved out of cross bite. A labial root torque would be required for esthetics and stability of this correction.

Torquing auxiliary can be used in the Begg appliance system. In the PEA appliance, this labial root torque can be achieved by placing

the bracket with the built-in torque, upside down on the involved crown.

- v. *Age of the patient and timing of the treatment:* Depending on the age of the patient and the eruption status, different appliances can be designed to correct anterior cross bite. In the pre-adolescent age group, different interceptive measures are undertaken to correct cross bite. These measures are discussed below.

- *A tongue blade appliance:* This is used to correct a developing anterior cross bite when the clinical crown has just made its partial appearance in the oral cavity and when sufficient space is available for correction (Fig.14.2).

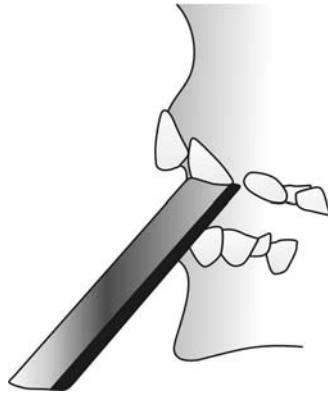


Fig.14.2: Diagrammatic representation of tongue blade therapy

- *Lower anterior inclined plane or CATLAN'S appliance:* This may be used for a single tooth or a segment in cross bite. The lower inclined plane is constructed at an angle of 45° to the maxillary occlusal plane and is cemented on the mandibular incisors. But, there are some pre-requisites for the indications of this anterior mandibular plane. These Are:

- The maxillary teeth in cross bite should be erupting posterior to the actual tooth position and there should be adequate space for their alignment.
- Also, the mandibular incisors should be well aligned to allow placement of the appliance.

But, the main problem associated with this appliance is that it separates the opposing posterior teeth and causes difficulty in speech and chewing. Also, it might have to be re-cemented frequently.

- *A removable appliance with 'Z' springs:* 'Z' spring can also be technically called *Double Cantilever Spring*. 'Z' springs are incorporated in the removable appliance and are placed on the lingual surface of the incisors to be moved. The parallel arms of the spring can be activated in such a way that the entire tooth can be pushed labially or the mesial or distal aspect of the tooth can be pushed labially as per the tooth movement required. Again, adequate space should be available for aligning the teeth in cross bite. In mild-moderate deep bite cases, it is advisable to incorporate buccal capping of posterior teeth to free the teeth to be moved from contact with the lower arch (Fig.14.3).
- *Removable appliance with jack saw:* When the maxillary anterior arch has enough space to accommodate lingually inclined

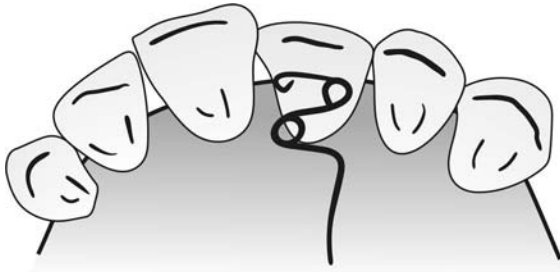


Fig.14.3: Upper removable appliance with 'Z' spring to move the incisor anteriorly

incisors in cross bite, then, simple forward tipping of these inclined incisors would be the treatment of choice. A removable appliance with jack saw for forward movement of the anterior segment is a favorable choice.

The acrylic appliance incorporates a screw in such a way that it can move a single anterior tooth or anterior tooth segment labially by directing the anterior acrylic segment forward. Posterior bite blocks just enough to create overbite clearance should be incorporated in this maxillary removable appliance. The segment of acrylic anterior to the screw should contact the lingual surface of the incisors to be moved forward.



Fig.14.4: Removable expansion appliance for labial movement of the anterior segment

To reinforce the tooth movement, incisors to be moved can be clasped with special south end clasp with its ends incorporated in the lingual anterior acrylic segment (Fig.14.4).

- *Reverse stainless steel crowns:* These can be placed on upper incisors (single tooth cross bite) if lower incisors are previously displaced labially.
- *A 2 × 4 fixed appliance:* A short term fixed appliance therapy with a 2 × 4 appliance can also be chosen as the appliance can be easily retained in the mouth during mixed dentition period. Four (4) incisors are bracketed and 2 molars are banded (thus 2 × 4 appliance). Multi-looped arch wire, which can be activated by stretching the inter-bracket span of the wire, is placed to pull the teeth forward out of cross bite.

If the anterior cross bite is encountered in the permanent dentition period, that is in adolescents and adults, the following approaches can be instituted:

- a. *Removable appliance with jackscrews*: Mini or medium jackscrews can be incorporated in the appliance for anterior movement of a single tooth or anterior tooth segment. Adequate space should be present or gained before activating the appliance.
- b. *A combination of fixed and removable appliances*: This is the best method for correction of anterior cross bites in relation to Class I malocclusion.
 - i. A fixed appliance is positioned on the upper arch. Pre-adjusted appliance is most appropriate and is recommended for correction of anterior cross bite because of its precise root controlling ability. If adequate space is not present for correction of cross bite, it can be gained by either proximal slicing or extractions.
 - ii. A posterior removable bite block is placed on the lower arch. It is used to open the bite (in the case of locked incisors) so that lingually positioned incisors could be moved forward.
 - iii. Cross bites are corrected by alignment of teeth with flexible arch wires; CO-CR shift present would disappear.
 - iv. After correction of the cross bite, lower teeth can be aligned with a fixed appliance after removing the bite block. Remember not to align lower anterior teeth before correcting the cross bite.
 - v. The fixed appliance extrudes the lingually placed maxillary incisors after bringing them forward out of cross bite. This helps in maintaining the required over bite to retain the correction.

Factors Influencing the Correction of Anterior Cross Bites Associated with Class III Malocclusion

- i. Anterior cross bite with Class III should be treated early especially with a displacement, provided sufficient over bite exists to retain the correction.
- ii. Pseudo Class III malocclusion can be corrected by eliminating the CO-CR shift and then a small period of appliance therapy might be needed as mentioned for anterior cross bites with Class I molar relation.
- iii. Skeletal cross bite would be present in true skeletal Class III malocclusions. A reverse over jet is present with more than 2 anterior teeth in linguo-occlusion. This is due to either a large mandible or a retrusive maxilla or an anterior position of the mandible relative the maxilla.
- iv. There might be a dentoalveolar compensation in skeletal cross bites as the patient tries to achieve an anterior oral screen. This leads to

retroclination of the lower incisors and proclination of the upper incisors making the incisor relationship less severe than the underlying skeletal pattern. Dental crowding could be present in the upper arch.

- v. If the skeletal pattern is mild, then forward positioning of upper labial segment should be the treatment approach. If the skeletal pattern is moderate, appliance to procline upper labial segment and retrocline lower labial segment should be the treatment approach.
- vi. *Age of the patient and timing of the treatment:* During active growth period, myofunctional or orthopedic appliances should be employed for actual basal skeletal correction.
 - *Facemask along with rapid palatal expansion:* This can be used if the anterior cross bite is due to an actual skeletal deficiency of maxilla. Rapid maxillary expansion may be employed to transversely expand the narrow maxilla. A protraction facemask (a reverse headgear) should be employed to mesialize the maxilla.
 - *A chin cup appliance:* This may be used to redirect the growth of a prominent mandible by rotating the mandible downward and backward. This change would either prevent a future anterior cross bite or correct the existing anterior cross bite.
 - *Frankel-III appliance* is a myofunctional appliance that stretches the soft tissues, surrounds the maxilla and stimulates its anterior growth. It also prevents any further growth of the mandible. Thus, it can be used to correct a developing skeletal Class III malocclusion leading to a skeletal anterior cross bite.

If the condition is encouraged in the adolescent or adult period of life, then the following approach should be adopted.

 - *Mild skeletal problem:* Fixed appliances to procline the upper labial segment should be employed.
 - *Moderate skeletal problem:* A camouflage approach is required. A combination of fixed appliances with extra-oral appliance should be used to procline the upper labial segment and retrocline the lower labial segment with or without extraction of premolars.
 - *Severe skeletal problems:* A combination of orthognathic surgery and orthodontic treatment should be carried out to correct the discrepancy after all possible growth is completed.

MANAGEMENT OF POSTERIOR CROSS BITES

Factors influencing the correction of posterior cross bites associated with CI-I, CI-II and CI-III malocclusion are discussed below.

i. *Inclination of teeth involved in a cross bite:*

- If upper molar in cross bite is inclined lingually, then, tipping of the molar buccally should be the treatment approach.
- If the upper molar in cross bite is inclined buccally, then, widening the upper arch could be the treatment approach as this inclination of molar is mainly due to the narrowness of the upper arch.

- If the lower molar in cross bite is inclined lingually, it indicates width discrepancy between the upper and lower arch; so, methods to co-ordinate the arch widths could be followed.
 - If the lower molar in cross bite is inclined buccally, then, lingual tipping of the molar may be favorable.
- ii. *Unilateral or bilateral existence of cross bite:* In the cases of unilateral posterior cross bite, one should always check whether the cross bite is truly unilateral or it is due to a lateral functional shift of the mandible towards the side with cross bite when it is closed into centric occlusion.
- This lateral shift is detected by a deviation of the lower dental midline towards the side with cross bite.
 - Also, a mouth-opening test can be done to confirm the presence of lateral shift. Upon opening the mouth wide, if the lower dental midline shift is present, it confirms the presence of lateral shift.
 - Thus, when a lateral functional shift is detected, it means that cross bite is bilateral in origin and should be treated with bilateral expansion approach.
 - But, if no functional shift is detected in a unilateral posterior cross bite, it means that the cross bite is due to a skeletal or dentoalveolar asymmetry. Unilateral cross elastics or unilateral expansion mechanics should be used as the treatment approach.
- iii. *The extent of expansion required:*
- a. If the estimated expansion needed for upper arch is 4 mm and the upper molars are inclined lingually, then, slow dental expansion is the right approach. This can be carried out with any of the following appliances:
 - Removable appliance with jackscrew
 - Quad helix or 'W' spring appliance
 - Coffin spring appliance
 - Wide arch wires in fixed appliances
 - b. If the expansion required is between 5 mm and 12 mm, it indicates true narrowness of the upper arch. Usually, in this case, the upper molars in cross bite are abnormally inclined buccally. Here, rapid maxillary skeletal expansion is the right treatment approach. A fixed hyrax maxillary mid-palatal expander with expansion screws can be used for this skeletal expansion.
 - c. If the expansion needed is greater than 12 mm, a surgically assisted expansion is the right treatment approach.
- iv. *Over bite changes related to changes in cuspal contacts:* Upon correcting the cross bites, the lingual cusps of the corrected upper posterior teeth make contact with the occlusal surfaces of the lower posterior teeth and transiently open the overbite to some extent. So, patients with an anterior open bite should be carefully handled while treating the posterior cross bite.
- v. *Age of the patient and timing of the treatment:*
- a. If unilateral posterior cross bites with a lateral shift are detected early,

then it is best to treat these actually bilateral cross bites during primary and mixed dentition period.

- Prolonged presence of lateral shifts can lead to TM Joint dysfunction and complicate the treatment. Treating this condition in primary or early mixed dentition period allows the permanent successors to erupt into a normal occlusion after the lateral shift is eliminated.
 - If the unilateral cross bites with lateral shift are associated with Class I malocclusion, then, bilaterally maxillary expansion should be done. This would automatically eliminate the lateral shift.
 - The expansion devices used during primary and early permanent dentition would have an effect on both skeletal and dental components because of greater bony response at this age. The appliances delivering low forces like removable expansion appliance, 'W' arch and quad helix (both fixed palatal appliances easily retainable in the mouth) would be adequate.
 - When the unilateral posterior cross bite is associated with Class II malocclusion, then, a functional appliance for growth modification in early mixed dentition can be chosen. The working bite can be taken with a forward mandibular position to redirect the mandibular growth and this eliminates the functional shift. If a lateral shift leading to a unilateral cross bite is detected in early permanent dentition, then also, it can be treated by bilateral expansion methods. But, if lateral shift is allowed to persist till late adult age, joint changes develop and this condition has to be treated with special consideration for a skeletal asymmetry.
- b. Bilateral posterior cross bites are a result of maxillary constriction or mandibular expansion. In the early dentition phase, this is typically a result of constricted maxillary arch. Frequently, this maxillary constriction is associated with a thumb sucking habit. If the habit persists even after the eruption of permanent incisors, a Quad helix type fixed appliance would be the right choice as it would work as both a habit breaking reminder appliance and an expansion device to correct the developing cross bite. In a young child, both dental and skeletal changes would occur as a result of appliance therapy. In an older child, more dental and less skeletal changes would occur with low force magnitude appliances.

When orthopedic expansion is needed, the forces should be applied to separate the mid-palatal suture before the suture fusion occurs during adolescence. Once the suture closes at about 16 years of age, there is resistance of skeletal structures followed by increased fusion of the sutures. So, rapid palatal expansion would be less effective and less stable.

In adults, surgically assisted maxillary expansion would be required to increase the skeletal transverse dimension.



Fig.14.5: Removable screw appliance for uniform bilateral transverse expansion



Fig.14.6: Quad helix appliance for unilateral as well as bilateral transverse expansion. It can also simultaneously act as a habit breaking appliance

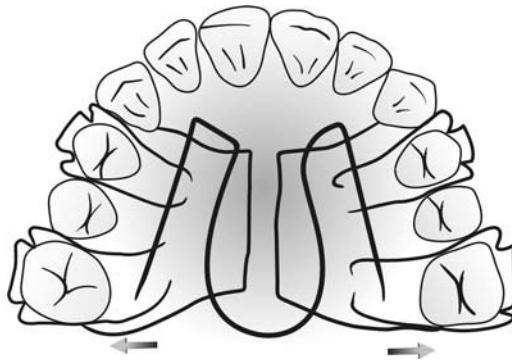


Fig.14.7: Coffin spring appliance for slow transverse expansion

- It comprises of retentive clasps and an omega shaped wire with base of the omega placed posteriorly in the midline of the two separate acrylic wings
- It should be activated up to 1mm per side at a time by pulling the wings apart

APPLIANCES FOR CORRECTION OF POSTERIOR CROSS BITE

- i. Removable screw appliance (Fig. 14.5).
- ii. Quad helix (Fig. 14.6).
- iii. Coffin spring (Fig. 14.7).

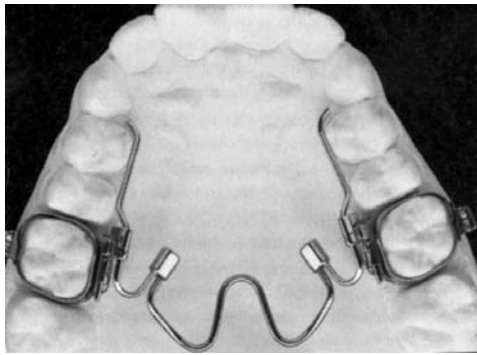
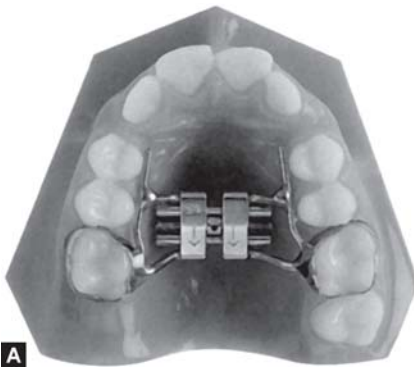
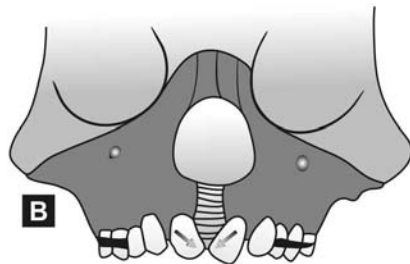


Fig.14.8: Ni Ti palatal expander to produce light and continuous pressure on the mid-palatal suture for slow transverse expansion (Courtesy: ORMCO)



Figs14.9A and B: A. Banded rapid palatal expander;
B. Bonded acrylic splint rapid palatal expander (Courtesy: ORMCO)



Figs14.10A and B: A. Rapid palatal expansion opens the mid-palatal suture with the appearance of midline diastema; B. The transeptal fiber traction after expansion closes the midline diastema within next six months

- iv. 'W' arch appliance
- v. Niti palatal expander (Fig. 14.8).
- vi. Hyrax rapid palatal expander (Figs.14.9A and B, 14.10A and B).
- vii. Cross elastics in fixed orthodontic appliances.

CLEFT

CLEFT means a split or a gap. An oro-facial cleft is a cranio-facial birth defect. The areas commonly affected by oro-facial clefts are:

- i. Upper lip
- ii. Alveolar ridge
- iii. Hard palate
- iv. Soft palate
- v. Nose (not very common though)

The terms for describing the oro-facial clefts are:

- i. Cleft lip
- ii. Cleft palate
- iii. Cleft lip and cleft palate

Before planning the management, it is important to have an idea about the etiological reasons behind the cleft. Any disturbance during the embryological formation of oro-facial region can lead to the formation of oro-facial clefts.

Heredity, drugs like cortisone, methotrexate, phenytoin, alcohol, stress, virus, increased parental age, nutritional deficiency etc. have been implicated as a few causes for cleft formation. The incidence of clefts in almost all the countries is about 1 in 700 births.

It is important to classify oro-facial clefts for ease of planning treatment. The best explanatory classification is the internationally approved classification of cleft lip and palate:

- A. *Group I*: Cleft of the anterior (primary) palate.
 - a. *Lip*: Unilateral, right/left, total or partial; bilateral.
 - b. *Alveolus*: Unilateral, right/left, total or partial; bilateral.
- B. *Group II*: Cleft of anterior and posterior palate (primary or secondary palate).
 - a. *Lip*: Unilateral, right/left, total or partial; bilateral.
 - b. *Alveolus*: Unilateral, right/left, total or partial; bilateral.
 - c. *Hard palate*: Right or left; total or partial.
- C. *Group III*: Clefts of posterior (secondary) palate.
 - a. *Hard palate*: Right or left
 - b. Soft palate

- D. *Group IV: Rare facial clefts*
- Median mandibular cleft
 - Double nose with unilateral cleft lip
 - Oro-ocular cleft
 - Oro-nasal-ocular cleft
 - Lip pits

CLEFT ASSOCIATED PROBLEMS

It is important to understand the oro-facial cleft associated structural, functional, physiological, esthetic problems to plan a multi-disciplinary treatment of these problems.

- i. *Associated dental problems (also referred as dental microforms):* Development of primary teeth, permanent teeth, jaws would be adversely affected with clefts of the alveolus involving features such as:
- Congenital absence of teeth (especially lateral incisors) or presence of supernumerary teeth.
 - Peg shaped lateral incisors.
 - Presence of natal or neo-natal teeth.
 - Ectopically erupting teeth—spacing or crowding.
 - Mobile teeth or early shedding of teeth due to poor periodontal support.

The teeth can be morphologically deformed or hypo-mineralized leading to following dental conditions:

- Enamel hypoplasia
- Fused teeth
- Aberrations in crown shape
- Microdontia or macrodontia

The maxilla would be underdeveloped exhibiting relative prognathism of the mandible leading to the following dental conditions:

- Class III skeletal jaw relation with underdeveloped maxilla and normal or slightly prognathic mandible.
- Constricted maxillary dental arch.
- Anterior and posterior cross bite.
- Protruding pre-maxilla could be present.

- ii. *Feeding difficulties:* Sucking of milk is difficult for babies due to lack of negative pressure in their mouth. The child would swallow a lot of air during feeding. If proper modified feeding habits are not introduced to the child, then the child could exhibit a poor nutritional status.
- iii. *Speech problems:* There is a nasal tone in these patients along with retardation in pronouncing consonant sounds (p, b, t, d, k, g). Abnormal tongue position and dental deformities produce articulation problems. Thus, phonation, resonance, articulation may be disturbed due to velopharyngeal incompetence, naso-oral communication, severe dental malocclusion, and pathologic lip involvement.
- iv. *Hearing impairment:* The opening of the auditory tube is affected, leading to middle ear infections causing loss of hearing and defective speech.

There could be lymphoid hyperplasia over the auditory tube orifice leading to hearing impairment.

- v. *Psychological implications:* The child is psychologically distressed due to his poor esthetics and functional disabilities. Birth of a child with oro-facial cleft is very distressing for the parents as well. This is further aggravated due to its socio-economic implications.

Thus, considering the nature of the associated problems, patients with cleft lip and palate require prolonged treatment with a team of specialized doctors. This team includes:

- | | |
|--------------------|------------------------|
| i. Pediatrician | ii. Pedodontist |
| iii. Orthodontist | iv. Oral surgeon |
| v. ENT surgeon | vi. Plastic surgeon |
| vii. Psychologist | viii. Speech therapist |
| ix. Prosthodontist | |

This team of specialized doctors is needed for the overall treatment plan, which aims at:

- i. Correction of the birth defect surgically.
- ii. Correction of speech, deglutition and esthetics.
- iii. Correction of dentition for normal function and esthetics.

The general management of a cleft patient requires an extensive and long term multi-disciplinary approach that starts immediately after the birth of child and continues till the child is 16-18 years of age with the general principles as follows:

- i. Pediatric and pedodontic consultations, feeding instructions etc. are necessary immediately after the birth. Spoon feeding or bottle feeding with a specialized teat having larger holes should be advised and the child should be burped often to throw the ingested air out.
- ii. Team evaluation during first few weeks after the birth is a must.
- iii. Surgical repair of lip—by 3-6 months of age.
- iv. Surgical repair of cleft palate—by 18 months of age with team approach.
- v. Speech assessment by ENT specialist and speech therapist—few months after surgical repair of cleft palate.
- vi. Speech therapy, treatment of middle ear infections, psychological evaluation between 3-6 years of age.
- vii. Lip and nose plastic surgery if necessary between 5-6 years of age.
- viii. Partial orthodontic correction at 7 years.
- ix. Full orthodontic correction at 12 years of age.
- x. After orthodontic correction, placement of prosthetic implants or fixed prosthesis for missing teeth between 15-18 years.
- xi. After growth completion, surgical advancement of maxilla if required—after 18 years of age.

Thus, the orthodontist also plays a major role in the treatment of cleft lip and palate. Extensive and prolonged orthodontic treatment may be required in patients with cleft lip and cleft palate.

Orthodontic management can be divided into four stages:

Stage One

It is carried out in infancy before the surgical repair of the lip.

- a. *Infant orthopedics* might be required at this stage to reposition the distorted arch segment, which is needed for a good surgical repair of the lip. This may be done before eruption of any primary teeth in the infant. Lack of lip tissue pressure and division of the alveolus in cleft cases result in a distorted maxillary arch with an outward displacement of pre-maxilla (in bilateral clefts) or an outward displacement of the greater segment (in unilateral clefts). Thus, two types of movements of the maxillary segments may be needed to achieve an upper arch form that conforms to the lower arch. These are expansion of the collapsed maxillary posterior segments and contraction of the pre-maxilla by pressure against the pre-maxilla. Repositioning can be achieved quite easily and rapidly in infants so that the pre-surgical movements of the maxillary arch can be started at 3-6 weeks of age and can be completed by 8-9 weeks of age. Then, the surgical repair of lip can be done at 10-12 weeks of age.

The orthodontist can try to correct the distorted maxillary arch by extra-oral strapping across the pre-maxilla, which can be attached at some part of face or to a head cap. In some instances, micropore adhesive tapes have been strapped across the pre-maxilla. For expanding the collapsed maxillary posterior segments, a removable appliance with expansion screw or springs can be used.

These two maxillary movements, as a part of infant orthopedics, are very advantageous as they bring about partial obturation of the clefts, and thus:

- Aid in surgery
 - Assist in feeding
 - Reduce the size of the defect
 - Improve speech
 - Reduce the number of ear infections
 - Stimulate palatal growth
 - Improve esthetics
 - Partially de-stress the parents.
- b. *Passive maxillary obturator or a 'feeding plate'*: This passive plate can be placed little before the surgical lip closure and can be maintained for 3-6 months after lip closure. This is an intra-oral prosthetic device to fill the palatal cleft and provide an oral seal against which the child can swallow. It reduces feeding difficulties like lack of negative pressure for suction or excessive air intake while feeding and choking. Apart from this, it stabilizes the repositioned maxillary segments and prevents the re-collapse of posterior segments.

Impression of the palate can be taken. Undesirable undercuts can be blocked in the cast and plate can be made with self-cure acrylic. Wire bows that follow the cheek contour extra-orally can be incorporated

in the palatal acrylic and the wires can be stabilized extra-orally with the help of micropore adhesive tapes.

Surgical repair of lip by a team of specialized surgeons (ENT surgeon, oral surgeon, plastic surgeon): A rule of ten should be followed for this surgical procedure i.e. surgery should not be performed less than 10 weeks of age; body weight should not be less than 10 pounds and the blood haemoglobin should not be less than 10 grams.

Early lip closure has a molding effect on the arch and improves the facial appearance and reduces the apprehension of parents. The operation is done under general anesthesia. So, all precautions should be taken to ensure that the child is safe enough for undergoing a general anesthesia procedure. When the date of surgery is fixed, bottle feeding should be stopped and the child should be started to be fed with spoon at least 1-2 weeks before surgery.

Surgical repair of cleft palate is, then, done between 16-20 months of age. The objective of surgery is to provide a long and mobile palate and close the pharyngeal isthmus during speaking and swallowing. Some centers prefer to close the soft palate at this time, but hard palate is not repaired till 6-8 years of age so that it may not interfere with growth.

Stage Two

It is carried out during late primary and early mixed dentition treatment. By this time, the initial lip repair and cleft repair have already been done. But the surgical closure of lip almost always creates some constriction across the anterior part of the maxillary arch and the surgical closure of cleft palate causes some lateral constriction. Hence, there might be presence of anterior and lateral cross bite, which means that orthodontic correction and rehabilitation is very essential for these patients.

Thus, interceptive orthodontic procedures are indicated at this time and should be ideally started after the eruption of permanent incisors, which are usually rotated or are in cross bite relationship. So, the major goals of orthodontic treatment of cleft patients at this stage are:

- i. to correct the gross incisor rotations and inclinations.
- ii. to correct the lateral cross bite by using rapid palatal expansion or quad helix appliance.
- iii. to correct the maxillary retrognathism, if present, with a reverse pull headgear.
- iv. to prepare the patient for an alveolar bone graft. A bone graft should be placed in the alveolar cleft area before the eruption of permanent canines, which should erupt through the graft. The bone graft stabilizes the cleft area. But remember that the incisor alignment and palatal expansion should be completed before placing the alveolar graft. This is, usually, a cancellous bone graft obtained from the iliac crest.

The Nitinol expanders have proved to be very useful in cleft patients with transverse and antero-posterior maxillary deficiency (Fig.15.1). The Nitinol expander creates transverse maxillary expansion, uprights and de-rotates the maxillary molars. There is no requirement of patient compliance and little clinician's manipulation is expected (Fig.15.2A and B).

Preformed Niti expanders come in 8 sizes according to the inter-molar width and expansion required. Nitinol expander is thermal activated palatal expander, which produces light and continuous pressure on the mid-palatal suture. When it is chilled before insertion, it can be easily bent to facilitate its placement. As the appliance becomes warm by mouth temperature, the metal stiffens and the shape memory of Niti gets restored and the expander gets activated. If there is too much discomfort in the mouth, the patient can be advised to sip cold water, which would make the forces lighter by increasing the flexibility of the expander. Thus, this convenient, non-bulky, and easily efficacious expander is ideal for cleft patients who have been traumatized by multiple surgeries.

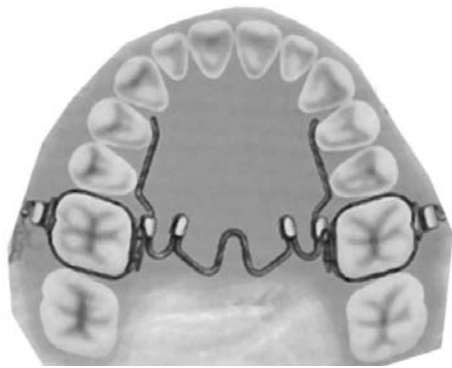


Fig.15.1: Ni Ti palatal expander for transverse expansion and de-rotation of maxillary molars
(Courtesy: Ortho organisers)

Stage Three

It is carried out during early permanent dentition period. Complete orthodontic correction and final alignment of teeth is carried out at this time, preferably by using fixed orthodontic appliances. Orthodontic treatment is also essential at this time to reposition the teeth as abutments for later fixed prosthesis semi-permanent acrylic bridge can be helpful for replacing missing teeth. But permanent bridges should not be placed till

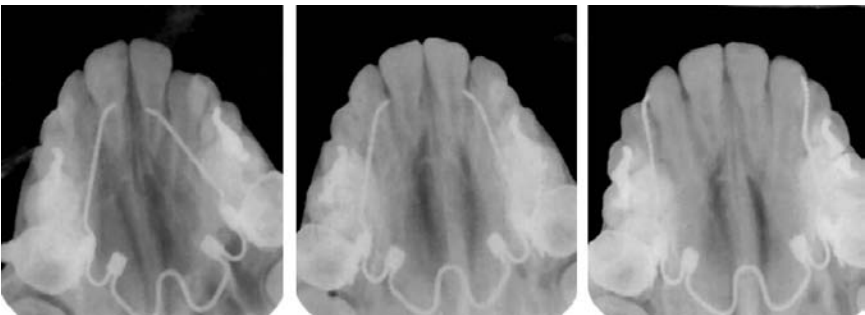


Fig. 15.2: Patient progress with Niti-palatal expander in mouth

the patient is 18 years of age. Dental implants are contraindicated for placements in cleft areas.

Retention after orthodontic treatment in cleft palate cases: Retention, here, is usually for a prolonged period or in some cases for a lifetime due to:

- Lack of bone stability and contracture of post-surgical scar tissues.
- Missing teeth and abnormal tongue posture.

In these cases, the orthodontist can join hands with the prosthodontist to provide a retention appliance that can also be made to serve as a prosthetic replacement for missing teeth. The retainers could be removable or fixed. Removable retainers also aid in rehabilitation and speech correction. Fixed anterior bridge serves as a retainer, replaces the missing teeth and also unifies the repaired cleft segments.

Stage Four

Stage four of orthodontic treatment is carried out in late teens after completion of facial growth. Skeletally deficient mandible or advanced mandible due to continued growth of the mandible after orthodontic treatment may require orthognathic surgery. This surgery may be done by the age of 18 years to bring the deficient maxilla downward and forward or a surgical mandibular setback may be required in some cases.

A BRIEF DESCRIPTION OF SURGICAL PROCEDURE FOR CLEFT LIP REPAIR

1. Symmetry of the lip is observed.
2. Prolabium should be used to form the full vertical length of the middle of the lip. The vermilion ridge of the prolabium should be preserved and this could be used to form the central part of the lip.
3. Muscles are brought into the prolabium and released in both the segments and midline suture is taken.
4. Keep the prolabial lip or the central portion of the lip adherent to the alveolus, leaving adequate upper buccal sulcus.
5. If each side of the bilateral lip cleft is repaired one at a time, the interval between the two repairs should be 3-4 months.

A BRIEF DESCRIPTION OF THE STEPS FOR SURGICAL REPAIR OF CLEFT PALATE

1. Bilateral unipedicled mucoperiosteal flaps are raised based on the greater palatine arteries.
2. The nasal mucosa is transected and detached from the nasal side of the palatal shelves.
3. Anteriorly, the nasal floor is repaired by suturing the vomerine mucosa to the nasal mucosa on the cleft side.
4. The soft palate is closed on three layers: nasal, muscular, and oral.

5. The oral mucosa is re-approximated in the midline with horizontal sutures.
6. In the case of complete cleft lip and palate deformity, anterior palate is repaired along with the lip.

The management of cleft lip and palate is quite challenging and exhaustive and the orthodontist plays an important role in rehabilitating these patients.

Let us first know the meaning of retention and relapse. Relapse may, sometimes, follow retention if proper care is not taken. Knowing the meaning of relapse in orthodontics, first, may be in order.

Relapse is the tendency of orthodontically treated teeth to revert back to their original position. There is a histological evidence that the bone is responsive to pressure for a period of at least 6 months after the teeth have been moved to their new position. The trabeculae of bone are resorbed and reformed in a general direction parallel to that of force applied to the tooth and this trabecular reorientation is completed in about 6 months. The bone during this period is found to be more responsive to the influence of pressure produced by faulty inter-digitation of teeth or to forces produced by lips, cheeks, tongue during their resting phase or to abnormal forces produced by persisting oral habits or to tension produced by elastic recoil of gingival fibers. Thus, occlusion is not able to hold the teeth in their new position. This leads to relapse of the malocclusion and hence, it is utmost necessary after active orthodontic treatment to prevent the tooth from returning to its original position by means of a retention appliance for at least 6-8 months.

In short, the causes of relapse can be described as:

- i. *Bone adaptation:* The bony trabeculae are normally arranged perpendicular to the long axis of the teeth, which get aligned parallel to the direction of force during orthodontic treatment. Thus, teeth that have been orthodontically repositioned are not adequately stabilized in the lightly calcified osteoid bone. Hence, they should be allowed to stabilize in their new position when the bony trabeculae revert back to their normal arrangement during the retention phase.
- ii. *Periodontal ligament traction:* When the teeth are moved to a different position, the periodontal fibers that encircle the teeth are stretched and then contract. The principal periodontal fibers reorganize themselves in about 4 weeks while the supra-alveolar gingival fibers are more sluggish and take around 40 weeks for reorganizing themselves in the new position and hence, predispose the dentition to relapse. Thus, a period of 10-12 months of retention should be provided for all the fibers to rearrange and readapt to the new dental positions.
- iii. *Failure to eliminate the original cause of malocclusion:* As described in the treatment of all malocclusions, the etiology of the condition should

be understood and root cause for a particular manifestation should be determined before the treatment planning. Adequate treatment steps should be planned first to eliminate the original cause or to reduce in severity. Failure to do so would result in unstable results leading to relapse of the treated malocclusion.

- iv. *Muscle imbalance*: Lack of balance between the buccal and lingual oral forces at the end of the orthodontic treatment may cause instability in the treated condition and hence, which can lead to a relapse.
- v. *Growth related changes*: Continued abnormal growth after orthodontic therapy in the cases of Class II, Class III, open bite or deep bite can cause relapse of the treated condition.
- vi. *Incorrect diagnosis and treatment*: Successful retention of orthodontic cases depends on correct diagnosis and correct treatment mechanism that establishes a structural balance of all the forces of occlusion. Failure to do so leads to relapse of the condition.
- vii. *Abnormal occlusal forces*: Correct inter-digitation of upper and lower teeth is important for the stability of treated cases. Faulty inter-digitation of teeth produces abnormal occlusal forces on the supporting structures leading to instability and relapse. Also, abnormal reduction of inter-occlusal space may produce abnormal occlusal forces that can cause relapse.
- viii. *Incorrect axial inclinations towards the end of orthodontic therapy*: Failure to upright the roots can open up the extraction spaces.
- ix. *Role of third molars*: The third molars usually erupt between 18-21 years of age. Orthodontic treatment might be completed before this without considering the eruption possibilities of 3rd molars.
- x. *Persisting abnormal oral habits* can produce pressure on the unstable alveolus and dentition, leading to relapse.

Thus, it is clear that a phase of retention with some form of retention appliance is mandatory after a corrective orthodontic phase. Without a retention phase, a well planned and successfully treated case would be a failure due to instability and relapse of the treated condition.

So, let us now define *retention*.

RETENTION

Retention is defined as the maintenance of moved teeth in the new position long enough to aid in stabilizing their correction. Also, retention is the holding of teeth in an ideal esthetic and functional position for a period long enough to aid in stabilizing their correction.

General Considerations in Planning Retention

- i. Elimination of the cause or the oral habits, if any, is the first step towards successful treatment and prevention of relapse.
- ii. Malocclusions should always be over-corrected as a safety factor because some degree of relapse almost always occurs in spite of use of retentive measures.

The conditions where over-corrections are required are:

- *Molar relationship*
 - Class II molar relation should be over-corrected to super Class I molar relationship.
 - Class III molar relation should be over-corrected to Class II molar relation, if possible.
 - *Deep bite* should be over-corrected to almost an edge-to-edge bite, which would revert to a normal over bite in some time.
 - *Open bite* should be over-corrected to a slight deep over bite, which would revert back to normal over bite.
 - *Rotations* should be over-corrected to allow some degree of relapse.
- iii. The treatment should be ended when all the teeth are in proper occlusion and proper inter-digitation to avoid generation of abnormal occlusal forces.
 - iv. Bone and supporting fibers should be allowed to reorganize themselves around the newly repositioned teeth and hence, some form of retentive measure should be provided during this time.
 - v. Corrections carried out during growth periods are less likely to relapse because of maximum utilization of growth, with concomitant tooth eruption. The skeletal mal-relations corrected in this phase allow sutural correction as the sutures are morphologically more amenable to alteration. Also, relapse can be avoided by development of a favorable muscle balance, which would promote desirable growth and allow more normal development of dentition.
 - vi. The teeth should be positioned in relation to the apical base to achieve correct occlusion and retention. Lower incisors should be positioned upright over the basal bone to keep them in good occlusion.
 - vii. Extractions of dental units should be considered as an important part of orthodontic treatment in the case of presence of excess tooth substance in relation to the arch length. Treatment following extractions in the cases of such arch length discrepancies results in more stable treatment results.
 - viii. Many treated malocclusions may require permanent retention because their natural retentive factors are not adequate enough to hold the teeth in their new position after discarding the retention appliance e.g. midline diastema or severe rotations, generalized spacing with deficient tooth substance in relation of jaw size, etc.
 - ix. Frenectomy, pericision and occlusal equilibration may be required in some cases to aid in their post-treatment retention along with retention appliances.

Retention can be planned according to the duration of the retention required. It can be grouped under the following headings:

Natural Retention

In this case, no retention appliance is required. There are certain conditions, which if treated well, do not require any post-treatment retention appliance

because natural retentive factors associated with them are adequate for self-retention. These conditions are:

- i. *Anterior cross bite*: When adequate overbite has been achieved, then no appliance would be required to retain the correction.
- ii. *Posterior cross bite*: When axial inclination of teeth remains reasonable after correction and occlusion ensures stability of tooth movement, no retentive appliance is required.
- iii. *Dentition treated by serial extractions*.
- iv. *Highly placed canine when brought into occlusion*.
- v. *Correction achieved* by retardation of maxillary growth once the patient has completed the growth.
- vi. *Dentition* in which space is regained by separating teeth to allow for eruption of blocked out or impacted teeth, e.g. alignment of impacted lower 2nd premolars after space regaining.

Standard Retention or Limited Retention

A majority of post-treated orthodontic cases fall into this group of retention because in these cases, teeth have been moved to positions of soft tissue and occlusal balance. Thus, teeth have to be retained until the alveolar bone and the periodontal ligament have been remodeled, which takes around a period of 6-10 months. Full time retention is a must for the period of 6 months and a part time wear of the appliance would be adequate in the last few months and gradually tapering the appliance wear till it is discontinued.

Orthodontic cases that fall under this group are:

- Class I non-extraction cases with proclined and spaced maxillary incisors.
- Class I and Class II extraction cases.
- Correction of rotation before root completion.
- Class II div 2 cases: Retention can be slightly extended to allow for muscle adaptation.
- Corrected deep bite cases.

Permanent or Semi-permanent Retention

In these cases, the intra-arch stabilizing factors and natural retentive factors are not sufficient to hold the treated condition after discontinuing retention; hence, a good option is to take measures for a permanent or semi-permanent retention. Orthodontic cases that fall into this group are:

- *Midline diastema closure*: Even if frenectomy is done, there are chances for small space to open up between the upper central incisors, which are unsightly and esthetically unacceptable.
- *Considerable generalized spacing* where there is relative deficiency of tooth substance, permanent retention by means of esthetic restorations are considered best.
- *Expansion of mandibular arch* where expansion has been done to avoid extraction.

- *Initial lower anterior crowding* has a tendency to recur after treatment due to differential mandibular growth between the age of 16-20 years.
- *Severe rotations.*
- *Expanded arches in cleft palate patients.*

METHODS OF RETENTION

Retainers are used for retention. Retainers are positive orthodontic appliances that help in maintaining and stabilizing the position of orthodontically treated teeth to permit reorganization of supporting structures.

There are two types of retainers or retentive appliances:

- Removable retentive appliances
 - Extra-coronal
- Fixed retentive appliances
 - Intra-coronal
 - Extra-coronal

REMOVABLE RETENTIVE APPLIANCES

These are most frequently delivered retentive appliances and serve for retention against intra-arch instability and can also be used as retainers in the form of modified functional appliances in patients with growth problems. These are passive appliances that can be removed and reinserted by the patient. Hence, patient cooperation in wearing the appliances is a must. The importance of fulltime wear of these retainers must be explained to the patient for a complete successful result of the treatment.

Most commonly used removable retainers are discussed below.

Hawley's Retainer

It functions as an active retention appliance as some remaining band space after appliance removal, can be effectively closed by activating the labial bow of Hawley's appliance. Also, a bite plane can be added in the palatal region to control the overbite. For patients with initial deep bite, light contact of incisors against the anterior plane of base plate is a positive factor.

It consists of a labial bow extending from canine to canine and retentive Adams clasps on the first permanent molars and acrylic that covers the palate incorporating these wire endings (Figs.16.1 and 2). A modification of the Hawley retainer in extraction cases is a continuous labial

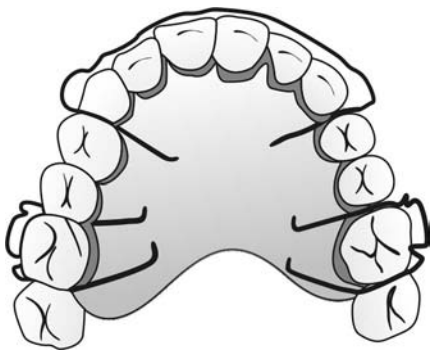


Fig.16.1: Hawley's retainer on the maxillary arch with Adams clasp on molars and a canine-to-canine labial bow and acrylic base on the palate

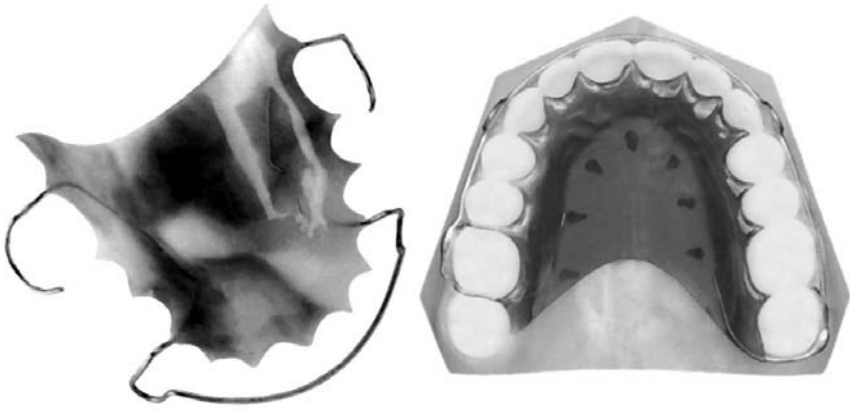


Fig.16.2: Certain modifications of Hawley's retainers (Courtesy: ORMCO)

bow soldered to the buccal section of the Adams clasp on the first molars. The action of this bow helps to hold the closed extraction site.

Alternative design for extraction cases is long labial bows with loop end passing distal to the 2nd premolar in the case of 1st premolar extraction case and circumferential clasps on 2nd molars. Hawley's retainers can be made for both upper and lower arch. Other modifications of Hawley's retainers are:

- Hawley's retainer with light elastic replacing the labial bow.
- Hawley's retainer with labial bow crossing distal to the lateral incisor and short distal extension controlling the canine avoids occlusal interference of the retentive arms of the labial bow.

Begg's Retainer

The labial bow extends distally posterior to the last erupted molar to be embedded in the acrylic base plate. There is no wire framework crossing the occlusion; hence, it is ideal for cases where settling of occlusion is required (Fig. 16.3). Also, it eliminates any chances of space opening. This was designed by Raymond Begg.

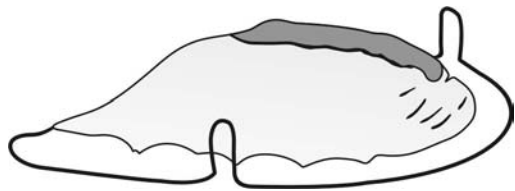


Fig.16.3: Begg's retainer for maxillary arch

Single Arrowhead Wrap Around Retainer

It is a modified Begg's retainer indicated in cases with partially erupted third or second molars.

Clip on or Spring Aligner

There is a wire framework running labially over the incisors and then passes between the canine and premolar. The lingual and labial wires are

embedded in a strip of clear acrylic. Usually, a canine-to-canine clip on retainer is widely used in the lower anterior region, mainly to realign the mild crowding, if present, after treatment. Upper canine-to-canine clip on retainer is used less frequently in adults and is not well tolerated in younger patients as it interferes with the occlusion.

Wrap Around Retainer

This is quite similar to the spring aligner but covers all the teeth with a strip of acrylic. It consists of a wire reinforced plastic bar along the labial and lingual surfaces of teeth. A full arch wrap around retainer is usually indicated when periodontally weak dentition requires splinting the teeth together.

In other orthodontic cases, it is not well preferred over Hawley's retainers because it is less comfortable and also, not as effective in maintaining the overbite correction.

Tooth Positioners as Retainers

These were introduced by HD Kesling in 1945 as excellent finishing devices. Under special circumstances, they can be used as retainers. For example, in a patient with a tendency towards Class III relapse, a positioner can be made with jaws rotated somewhat downward and backward. This positioner can be useful as a retentive appliance in maintaining the introduced occlusion relationships and intra-arch tooth positions. However, there are a few drawbacks of positioners used as retainers. In most of the cases, these are as given below.

- They cannot be usually worn on a fulltime basis because of the bulk and difficulty in speech.
- As it cannot be worn on a fulltime basis, incisor irregularities might reappear after treatment.

It is made up of thermoplastic rubber and covers the entire teeth and portion of the gingiva (Fig.16.4). For the positioner to serve as a retainer precisely, correct recording of hinge axis is very important.

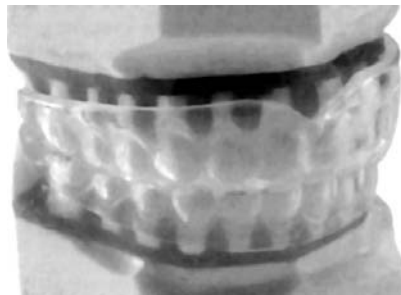


Fig.16.4: A precision positioner made with flexi clear material. It can serve as a retainer as well (Courtesy: ORMCO)

Invisible Retainers

These are made up of ultra thin transparent thermoplastic sheets using Biostar machine and are relatively esthetic and inconspicuous and so well accepted by the patients. Like the Kesling positioners, the material fully covers the clinical crowns and a part of the adjacent gingiva.

Myofunctional Appliances as Retainers

Modified functional appliances serve as active retainers. Almost all adolescents experience some vertical growth at the age of 17-18 years. Active orthodontic treatment started in early permanent dentition might be completed by 15 years of age. But differential jaw growth does not subside until about 18-20 years. Thus, the same growth pattern that led to malocclusion initially, can lead to a deterioration in occlusal relationship many years after orthodontic treatment is completed. Thus, certain skeletal malocclusion like Class II, Class III, deep bite or open bite that has existed due to an unfavorable growth pattern requires careful monitoring and management during retention.

In these cases, different myofunctional appliances can be used as active retainers with certain outstanding advantages like the ones given below:

- a. They can be used to maintain the corrected relation of the dental arches in any plane, e.g. antero-posterior, vertical and transverse.
- b. They can provide strong inter-maxillary anchorage to prevent unfavorable movement of teeth.
- c. They help in re-establishing the normal muscle behavior. But usually, certain muscle exercises can be instituted along with the appliances to aid in the maintenance of normal occlusion.

Activators, bionators, bite plates, Frankel appliances can be used as active retainers where the objective of their use is to control the residual growth and not bring about skeletal changes by growth modification.

In the cases of Class II treatment as a general guiding factor, prolonged retention would be required if more than 2 mm of forward repositioning of lower incisors occurred during treatment. Also, some post-treatment rebound is likely even after growth modification therapy. In Class II cases, upper jaw may show greater growth than lower jaw. Here, an activator or bionator can be used as a retainer to hold both the tooth position and the occlusal relationship. For maximum patient comfort, a combination retentive therapy should be instituted with conventional retainers during daytime and functional appliance as retainers during nighttime. The appliance should be continued as a part time retainer till the active growth is completed.

In the cases of Class III treatment, a Frankel III functional appliance can be used as active retainer. In mild or moderate Class III cases, one might require surgical correction.

In the post-treatment cases of deep bite, controlling the vertical overlap of incisors during retention is very important. A simple bite plane can be incorporated in the lingual part of the upper retainer in such a way that the lower incisors would contact the lingual acrylic of the upper retainer. This would prevent deepening of the bite after the orthodontic treatment. Initially, a fulltime wear of this retainer is required for a period of 1 year and then, only nighttime wear of the appliance can be continued for several years after treatment until all active growth is complete.

In the post-treatment cases of open bite, controlling the eruption of the upper molars during retention is most important. An open bite activator or an open bite bionator with bite blocks between teeth can serve as active retainers after the orthodontic treatment. Good patient co-operation in wearing the appliance on a gradual tapering basis for a long period till early twenties, is important in achieving good post-treatment stability and retention. Again, for better patient comfort, daytime regular retainers followed by nighttime functional appliance can be recommended.

FIXED RETENTIVE APPLIANCES

Fixed retainers are used in the cases where permanent or semi-permanent retention is required. Advantages of fixed retainers are given below:

- i. Can be used for permanent, anterior retention.
- ii. No tissue irritation; these are better tolerated by the patient.
- iii. Less patient co-operation is needed.
- iv. More esthetic.
- v. Does not affect speech.

There are certain disadvantages also. But, for the advantages of the fixed retainers, they should be used when indicated for all the cases where prolonged and permanent retention is required. Some of the disadvantages are discussed below.

- i. More difficult to place in the mouth and more chair side time is required.
- ii. Banded fixed retainers may make the oral hygiene maintenance more difficult.
- iii. They can break due to masticatory stresses.

Fixed Intra-coronal Retainers

These were used earlier but are not recommended these days because of availability of better methods and materials. Use of circumferential intra-coronal wire, acrylic splint or amalgam or composite intracoronal—interproximal splints were some of the methods of intra-coronal fixed retention. There is loss of healthy tooth structure in this technique. So, this method is usually replaced by better acceptable extra-coronal retainers.

Fixed Extra-coronal Retainers

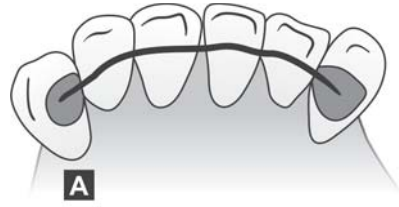
These are of four types:

- i. Directly bonded spiral wire retainers.
- ii. Prefabricated bondable lingual retainer.
- iii. Bonded mesh pad retainers (lingua).
- iv. Banded lingual retainers.
- v. Prosthetic replacements and esthetic restorations.

Directly Bonded Lingual Spiral Wire Retainers

These are most frequently used as a canine-to-canine retainer. A flexible spiral wire (28 mil) is recommended. The wire is made to rest over the flat

part of the lingual surfaces of incisors and the ends lie on the lingual surfaces of canines. Ends can be sandblasted for better retention of the bonding material. The wire is adapted correctly and held in place with the help of an adhesive wax or an inter-proximal dental floss and then is directly bonded with composite resin. All the teeth in the segment are bonded.



Prefabricated Lingual Retainer

The bondable lingual retainer is prefabricated in an arch form and requires only little adaptation. It can be placed prior to appliance removal while the case is bonded or can be placed after band removal (Fig.16.5A and B).



Figs16.5A and B: **A.** Fixed bonded retainer with mesh directly bonded on lingual surface of canines; **B.** Commercially available adjustable lingual retainer with bondable mesh pads

Bonded Mesh pad Retainers

A wire mesh pad is directly bonded to the lingual aspect of the teeth (Fig. 16.6).

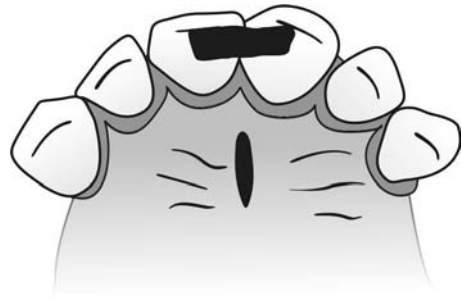


Fig.16.6: Bonded mesh pad retainer on the palatal aspect of teeth

Banded Lingual Retainers

Canines are banded and a wire is contoured and adapted to the lingual surfaces of incisors and welded to the canine bands (Fig. 16.7). These retainers are not very esthetic and pose difficulties for maintaining oral hygiene.

Prosthetic Replacements and Esthetic Restoration

In the cases of generated spacing due to missing teeth or small teeth in comparison to available arch length, the spaces in between teeth are reduced and redistributed by orthodontic treatment. Then, either esthetic enlargements (composite or porcelain veneers) or prosthetic

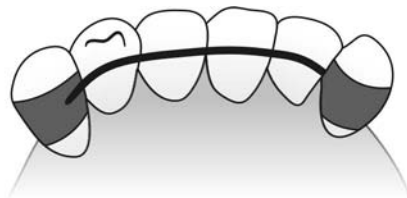


Fig.16.7: Fixed banded retainer with bands on canines

replacement of missing teeth is done. These replacements and restorations also serve as a means of permanent or prolonged retention.

Thus, the results of any orthodontic treatment are potentially unstable and hence, retention is necessary. The aim of orthodontic treatment should be to maintain the final desired result for a lifetime. Good post-treatment retention makes the orthodontic correction a life long satisfaction for the patients.

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